ANNUAL INDEX—JOURNAL OF CHEMICAL EDUCATION

Volume 7, 1930

To facilitate the use of this index a few explanatory remarks are offered. (See also pp. 2765–6.) Both author and subject indexes of the material appearing in the JOURNAL OF CHEMICAL EDUCATION during the year 1930 have been compiled.

AUTHOR INDEX

The author index consists of five parts as follows:

Articles
Correspondence
Abstracts
The Library, Sept., 1929–June, 1930
Books Reviewed

Under each of the five headings, which appear in the above order, the authors' names are listed alphabetically. In instances of joint authorship, each author's name may be found in its own alphabetical position. Following the author's name may be found the title of the article and the page reference. If the same author has contributed more than one article, the author's name appears only once, and all the titles are listed alphabetically under it.

SUBJECT INDEX

The subject index consists of ten parts as follows:

Articles
The Chemistry Student
Abstracts
The Library, Sept., 1929–June, 1930
Books Reviewed
Chemical Digests
Correspondence
Editor's Outlook
Frontispieces
Science Service Notes and Other Scientific News

Under each of the ten headings, which are arranged in the above order, all titles are listed alphabetically. In the alphabetical arrangement that part of the title before the comma has been given precedence. For example, the order for the following items is:

Aluminum, The Story of—
Aluminum Chloride, The Manufacture of Commerical Anhydrous—

In cases of hyphenated words, the hyphen has been ignored for purposes of alphabetical arrangement and the word considered as a single one.

The subject indexes for the **Abstracts** and for the **Books Reviewed** are classified under headings as follows:

Abstracts:
- **Apparatus, Laboratory Practice, and Demonstrations**
- **Teaching Objectives, Methods, and Suggestions**
- **Administrative Problems and Devices; Curricula**
- **Keeping Up with Chemistry**
- **Scientific Reviews and Bibliographies**
- **Historical and Biographical**
- **Educational Measurements and Data**
- **The Philosophy of Education**
- **The Philosophy of Science**
- **Professional**
- **Contemporary News and Comments in Chemistry and Education**
- **Foreign Chemical and Educational Conditions**
- **General**

Books Reviewed:
- **Books**
- **Miscellaneous Publications**

The titles under each of these headings are arranged alphabetically, and some titles have been cross-indexed and may be found under several of the headings.

In general, significant words in titles have been indexed, many titles thus appearing several times. For those titles which did not lend themselves easily to this treatment, there have been inserted (in italics) topics which will enable the reader to find such material more easily. See, for example, under **Articles:**

Antimony—See Questions for the Student of Elementary Chemistry

In the case of historical articles, in which the lives and contributions of several scientists are discussed, the separate names, as well as the title, have been indexed. For example:

Black, Joseph—See Scotland's Contribution to Chemistry

Furthermore, such topics as (1) *Apparatus*, (2) *Demonstrations*, (3) *Projects*, etc., have been inserted (in italics) and abbreviated titles, with page references of all articles pertaining to each, have been listed under the proper headings. Titles of articles appearing in the **Chemical Digest, The Chemistry Student, Correspondence,** and **Frontispieces** appear in the Article Index as well as in the separate indexes for these various sections of the JOURNAL. The titles of the headings of the various subject indexes, as well as the titles of the classification headings of the abstract subject index, have been inserted (in italics) with page references in the Article Subject Index.

The subject index for **The Library** covers items appearing from September, 1929, to June, 1930, these issues covering the entire period during which **The Library** was published in the JOURNAL. (It is being continued in *The Chemistry Leaflet.*)

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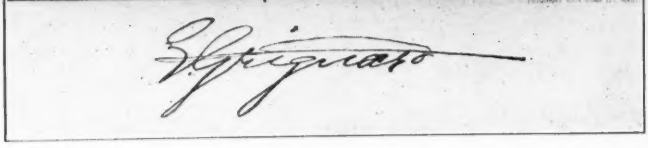

EDITOR'S OUTLOOK

THE Nobel Prize in chemistry for the year 1912 was awarded equally to Victor Grignard and Paul Sabatier, in the case of the former "for the so-called Grignard reagent, discovered by him, which, in recent years, has greatly advanced the progress of organic chemistry," and to the latter "for his method of hydrogenating organic compounds in the presence of thin plates of metal."

Victor Grignard, 1871– Grignard was born in Cherbourg on May 6, 1871. His preliminary training was received at the lycée of his native town and when he received his bachelor's degree there in 1887, he was two years too young to enter the Normal School at Cluny, to which he was finally admitted in 1889. At Cluny and later at the University of Lyon, he prepared himself for the *Licence-ès-Sciences mathématiques* and it was not until the year 1894 that he was persuaded by a fellow-student to undertake the study of chemistry, which hitherto he had held in aversion. Fortunately, at Lyon, he set to work in the laboratories of Bouveault and Barbier, under the spell of whose enthusiasm his prejudices melted away. Barbier had been interested for some time in obtaining a substitute for zinc in organo-metallic syntheses, and he put his young assistant to work on the substitution of magnesium in the Saytzeff reaction. Grignard proposed the idea that halogen alkyls alone in the presence of ether act on magnesium, but Barbier dismissed the suggestion with a smile. It was not until 1900, when Grignard took up independent research for his doctorate, that he felt free to pursue his own plan. The immediate outcome, the discovery of the Grignard reaction, gave no greater pleasure and astonishment to its inventor than to Barbier. Grignard set eagerly to work, testing out his discovery in numberless applications which gave an enormous impetus to the work of organic synthesis throughout the world. He presented the details of his discovery to science in his dissertation for the doctorate which he received in 1901.

His professional advance was rapid. Important appointments at Lyon and Besançon were followed by a call to the University of Nancy, where he was appointed as titular professor in the chair of organic chemistry in 1910. He has since returned to Lyon to direct the School of Industrial Chemistry. Prior to the Nobel award, he had received many honors, among them *le prix Cahours* in 1901 and 1902, *la médaille Berthelot* in 1902 and *le grand prix Jecker* in 1906.

Paul Sabatier, 1854– Sabatier,[1] who shared the Nobel award with Grignard, is a native of Carcassonne, where he was born on November 5, 1854. Prior to receiving his doctorate in 1880 he

[1] The portrait of Dr. Sabatier appeared as the frontispiece to the October, 1926, issue of THIS JOURNAL. See also in the same issue, Editor's Outlook, p. 1095, and the article "La Chimie Moderne et Marcelin Berthelot," pp. 1099–102, by Dr. Sabatier.

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worked as an assistant in the laboratory of Berthelot at the Collège de France. He has made many and important contributions in diverse fields of chemistry. His earliest interest was in physical chemistry. This was followed by a long period devoted to the study of mineral chemistry, but his outstanding investigations beginning in 1897 have been concerned with the organic field. All his work since 1884 has been performed at the University of Toulouse, in which his affections are so deeply rooted that he refused the flattering invitation to accept the chair left vacant at the Sorbonne by the death of Moissan.

As recently as 1926, the United States had the pleasure of entertaining this distinguished scientist and during the course of his visit, the American Chemical Society honored itself in receiving him into its honorary membership.

In the 1912 award of the Nobel prize in chemistry, the committee of the Royal Academy of Sciences of Sweden placed a seal on the value of method in the progress of science by selecting for the coveted honor these two who had performed not the least of services to the broadening of human knowledge by "forging new arms for the arsenal of science."

The Journal gratefully acknowledges the courtesy of Mr. Sederholm, managing director of Nobelstiftelsen, Stockholm, Sweden, in the gift of the accompanying portrait of Dr. Grignard.

Simplicity in Instruction

NOT long ago in these columns we wrote in favor of simplicity in elementary chemical instruction. Our informal thesis was directed specifically at the point that a relatively simple picture of the atom suffices as a working diagram to correlate and explain all of the phenomena commonly covered by the elementary course. The complications and refinements essential to an atomic model to account for a complete line spectrum are confusing rather than helpful in an elementary presentation of simple chemical reactions. Hence such details are superfluities to be avoided in dealing with beginners. A simple model should be employed with the frank statement that it is not intended as a representation of reality, but as a blueprint containing the features essential for our immediate purposes.

There is in some quarters, however, an apparent disposition to make simplicity an end in itself—a certain tendency to assume that the simplest possible exposition of any phenomenon is, *ipso facto*, the best possible presentation. This notion, we believe, involves fallacies which should not be allowed to pass unchallenged.

When simplicity consists in the elimination of irrelevant and useless detail it is a quality to be desired and pursued. When simplicity is interpreted as avoidance of the detail necessary to a lucid presentation of

fundamentals it is no longer a virtue, but a species of shirking. The use of the term in this sense is in reality a misuse. Simplicity is not synonymous with ease. The easiest explanation of any particular unit is not always the simplest (*i. e.*, the clearest and least confusing) explanation in the long run. It is very apt to be not even the easiest when viewed in the perspective of the course as a whole.

Those of us who teach chemistry by the unit system are sometimes too prone to fall into the error of dismembering our course into a number of separate and only loosely related entities. When we do this we are apt to make the further mistake of adopting methods which seem entirely satisfactory for isolated units but which leave much to be desired from the standpoint of the course as a whole.

There is a cumulative effect in the presentation of a unified course which should not be ignored. Fundamental and unifying principles may sometimes be difficult to present at first but they pay dividends at increasing rates as the course proceeds. Repetition and association of ideas operate to make learning easier as one goes forward.

There can be no doubt that instruction based on fundamentals is the most effective instruction in attaining the proper objectives of an elementary course. If there are two contributions above all others which instruction in the sciences should make toward the pupil's cultural development, those two are a recognition of the wide applicability of fundamental generalizations, and an appreciation of the scientific method. No course which consists in memorizing informational material on a series of apparently unrelated topics, or which involves the mastering of a number of semi-empirical methods of arriving at the correct answers to formal questions can by any stretch of the imagination be conceived as paying its way in the good, hard coin of desirable results achieved.

Education and Intelligence

SOME time ago there appeared in one of our popular periodicals a debate on the question: "Can education increase intelligence?" The most outstanding impression remaining with the writer at this time as a result of that debate is that the two debaters did not discuss the same subject. Each made out a fairly good case for his side of the question on the basis of his own interpretation of the term "intelligence." It was evident throughout, however, that each was in reality shadow-boxing with a phantom. There was no actual meeting of the two ostensible opponents.

This is one of the difficulties which attends all attempts to discuss or to measure intelligence and the extent to which it may be affected by various factors. One often wonders why the psychological house-cleaning which sent the "mind" to the attic did not do likewise by "intelligence."

Surely one is quite as much a reification as the other. Perhaps it was felt that we must retain a few linguistic conveniences even at the risk of objectifying abstractions.

Theoretically there is a possible way out of the difficulty. We might adopt some rigorous technical definition or criterion of intelligence and so give the term a special sense which would have real validity in psychology but which would not be synonymous with the sense implied in general usage. In fact it has been suggested semi-seriously that "intelligence is what the intelligence tests test."

However, we did not set out to commiserate with the psychologists on the difficulties that beset them. No doubt they deserve to suffer for being psychologists. Nor shall we presume to advise them how they may become scientists and so achieve salvation. We desire only to suggest that, so long as there is so little general agreement as to what intelligence really is, and so long as the psychologists have so little idea what they are really testing when they give intelligence tests, it might be wise to suspend judgment on some of the educational implications of their conclusions.

Some years ago they heaved the doctrine of formal discipline overboard with a tremendous splash. And to their credit be it said that they pitched a lot of nonsensical exaggerations and manifest absurdities after it. But now just when some of our practical teachers are beginning to hear rumors that there is a man overboard, the old doctrine seems to be on the point of climbing back in again, and there are some psychologists at least who stand ready to heave him a line and lend him a hand over the side. He is somewhat wan and reduced, it is true, and he has lost nearly all of his baggage, but he is the same stern old optimist.

In a recent address delivered before the Harvard Teachers' Association, Professor Frank N. Freeman[1] examines the types of evidence which have led many modern educators to the conviction that "it is impossible to improve the individual's general intelligence and that it is necessary to restrict education to very narrow and specific forms of training." These consist of experiments on the transfer of learning, of certain assumptions covering the inheritance of mental traits, and of certain interpretations which have been placed on the results of intelligence tests. Professor Freeman shows that some of these assumptions are unjustified, that a great deal of the statistical material available is capable of dual interpretation, and that the earlier experiments which were taken to indicate no transfer or only a very limited transfer of learning have been matched by others which seem to show a greater degree of

[1] "The Effect of Environment on Intelligence," *Sch. & Soc.*, **31**, 623–32 (May 10, 1930).

transfer. In addition he discusses several studies on identical and fraternal twins reared in the same, in similar, and in dissimilar environments. In so far as intelligence tests may be considered to measure intelligence, it appears that environment does have some effect. If environment, why not education?

> If we grant that the evidence seems to indicate that intelligence may be influenced by the environment, how are we to explain the effect of environment on intelligence? How are we to think of intelligence and to conceive of its growth or development? It is difficult to conceive of intelligence as affected by education if we think of intelligence or of learning according to the atomistic theory. According to this theory learning consists merely in the formation of particularized responses to particularized elements of the surroundings. A complex form of learning would consist simply in a large collection of these particularized responses. It would be made up of a large number of special bonds between elements in the situation and elementary responses. If learning is thought of, on the other hand, as the organization of experience and the organization of suitable responses to the environment, it is quite possible that learning one thing helps the learning of another and that a cumulative effect may be produced which brings about a real improvement in intelligence.
>
> What we call thinking is really such a process of organization. We learn to conceive of the features of our surroundings not as so many separate unrelated elements, but as grouped and organized in such a way that whole masses of them can be treated as units instead of as discrete elements . . . . This organization of the elements of our experience into organic units is what we call the formation of ideas. An idea may represent the organization of simple elements of experience into a larger unit. This idea may again become a unit in a larger organization. We carry on much of our thinking and much of our conversation in terms of these ideas. We do not go back to the original experience from which they are derived. The more ideas and the truer ideas a person has derived from his previous experience the better able he is to carry on the higher forms of organization which we call thinking. He is more intelligent because he is better able to deal with the problems that confront him, and this increase in intelligence is a product of his previous experience and his education.
>
> Whether this explanation of the way in which education may improve intelligence is correct or not, one practical point is clear. Whether education improves the intelligence will depend largely on whether the education is of a narrow specific sort or of the broader sort which encourages the development of ideas and generalizations. The kind of education we give the child, furthermore, will depend upon whether we believe in the possibility of the broader outcomes of education. This being the case it seems wise to give the child the benefit of the doubt and to provide for him the type of education which will develop his intelligence to the highest point of which he seems capable.

Many of us are glad to see this point of view advanced with some show of reason and authority. While the doctrine of specific training has undoubtedly induced educators to attempt to "define the aims and outcomes of education in more definite and specific terms," and while it has winged a few high-flown orators and brought them to earth, it has also had less desirable effects on educational philosophy. Some of us who have retained a wishful faith in the broader outcomes of education will be glad to know that, though we may be wrong, we are not just now both wrong and old-fashioned.

THE DIALYZER

(*For questions* 1–8 *see* pp. 1493–519.)

1. What industries flourished about 100 years ago in that section of New Jersey which has recently been devastated by forest fires?
2. Trace the formation of bog ore in New Jersey.
3. Name and locate some of the important furnaces and forges devoted to this industry.
4. Describe the methods used for digging and handling the ore.
5. What is a bloomary? Why is it so called?
6. Was the bog ore used other than for the iron obtained from it?
7. When and where in America were the first cast iron water pipes laid? At what iron works were these pipes cast?
8. What was the attitude of the British about 1750 toward the bog ore industry of the United States?

(*For questions* 9–10 *see* pp. 1520–36.)

9. What is the form of lead trees obtained in silica gel when zinc is used as the reducing agent? Does it differ from that obtained when (1) tin, or (2) cadmium, or (3) iron is substituted for the zinc?
10. How would you photograph successfully some lead trees grown in silica gel?

(*For questions* 11–13 *see* pp. 1537–43.)

11. When and from where were the first bananas imported into the United States?
12. How rapidly does the reducing sugar content of the banana change?
13. Does treatment with ethylene hasten the ripening of bananas?
14. Does the teaching of chemistry in the schools and institutes of France resemble that in the United States? (pp. 1544–9.)
15. Who was Anthony von Leeuwenhoeck? (p. 1552, pp. 1671–3.)
16. What is a cheap present-day commercial source of furfural? Name some uses of it. (pp. 1563–4.)
17. Why is "cracked" gasoline used as an anti-knock fuel for automobiles? (pp. 1580–7.)
18. Of what value is a course in organic qualitative analysis? (pp. 1588–96.)
19. With what class of elements is the name of Prof. Bohuslav Brauner allied? What celebration has recently been held in his honor? (p. 1592.)
20. What recent method has been proposed for deriving the stereochemical configurations of *d*-glucose and of *d*-galactose? (pp. 1599–601.)

(*For questions* 21–22 *see* pp. 1602–16.)

21. What are ammono aldehydes? Do they resemble the oxygen aldehydes in reactions? Give examples.
22. Show by reactions how hydrocyanic acid is related to the ammonia system of compounds.

(*For questions* 23–25 *see* pp. 1617–31.)

23. Which variety of peanut is most valuable for oil production?
24. What is the process used in the United States for the refining of the peanut oil?
25. Why do some peanut oils turn rancid more quickly than others?

(*For questions* 26–27 *see* pp. 1632–41.)

26. Distinguish between electrotypes and stereotypes.
27. What is a zinc line cut? A halftone?
28. Are you seeking a substitute for the formal laboratory notebook? (pp. 1642–4.)
29. How would you proceed in the laboratory to make Epsom salt from magnesite? (pp. 1656–8.)
30. How does your required equipment for freshman laboratory outfits compare with those of other institutions? (pp. 1683–7.)

THE BOG ORE INDUSTRY IN SOUTH JERSEY PRIOR TO 1845

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In a section of southern New Jersey there is a vast area which is very nearly devoid of any useful occupation. It is commonly known as "The Pines," "The Pine Barrens," "The Wilderness," and similar names. This section lies principally in the counties of Atlantic, Ocean, and Burlington and somewhat in Monmouth, Cumberland, and Cape May counties. In this section there once existed important industries such as lumbering, ship-building, glass-making, brick yards, salt works, paper mills, hunting, tanneries, turpentine distilling, and iron works. Today hunting is a sport to be pursued as the law allows; glass works flourish in the southern part of the State; two or three paper mills still survive; the other activities have long since ceased to function. With these businesses there were towns and roads and stage coach lines; some of the larger towns have survived, many have shrunk to mere hamlets, many others have disappeared. The old stage coach roads have almost followed the coaches—they are mere woodland trails well-nigh impassable. The so-called main roads are winding, rutted, and narrow. Turn-outs which were cut many years ago are still in use and in many places the remains of the corduroy roads may still be seen.

Now it must be remembered that this part of New Jersey is twenty minutes or less by air from Philadelphia and Atlantic City, and less than three-quarters of an hour by air from New York City. Its extremes are cut by an enormous volume of motor car travel; on the south, Philadelphia to Atlantic City and the southern resorts; on the north, Philadelphia to Lakehurst and Asbury Park and the northern resorts. These main roads are typical of any other main road in the country, but off these roads there is a different world. Along the roads in "The Pines" gas stations do not exist, bill boards and advertising signs are unknown, directional road signs are either absent or consist of weather-beaten boards nailed to a tree or post pointing in some general direction and on them are rudely painted the names of villages or towns—often with names misspelled or with the letters formed backward. Now and then along these roads there is a shack or house of one to three rooms in which the "piney" and his consort live. These shacks seldom have cellars, few windows, and none of the simplest conveniences of life. In several places it is difficult to distinguish the shack for humans from the shack for the horse and cow. Close to the house is a dugout whose rounded, sodded roof is two or three feet above the ground. This is for food storage and in times of necessity it has been used as a refuge from forest fires.

To be in "The Pines" at night does more to emphasize the desolation of this district than anything else. A winding, twisting road in the blackest night illuminated by intermittent flashes of blinding lightning shows the

region in all the gaunt nakedness of a fire-ravaged forest; hundreds of specters and skeletons of weird and demoniacal form flash into view, followed by ghostly distorted shadows appearing and disappearing in the auto headlights. Hardly less weird and unnatural is a bright moonlit night in "The Pines." The stillness is deafening, the deep and endless shadows destroy all sense of distances, the bogs, swamps, and forests are as still and forsaken as a painted ship upon a painted ocean; and as the crow flies Philadelphia is but thirty miles away. Here and there among the tree skeletons the dim light of a piney hut appears for a few seconds to emphasize the loneliness of the place. Gas and electric lights do not exist in this forgotten land, all lights come from oil lamps and candles; in direct contrast there appears a telephone line—the line of the forest service patrol which is the only sign that civilization is near.

It was in such country as this that the bog iron industry and the other activities flourished over a hundred years ago. Today there is nothing, not even ruins.

The bog iron industry of New Jersey was at one time one of the most important of the many industries in the State. It had everything at hand for success. The bog ore deposits were rich and very extensive; the forests gave an ample and inexhaustible supply of wood for charcoal; the streams were large and when dammed provided power for saw mills, grist mills, and for the trip hammers and bellows of the iron works. The majority of the streams also afforded a direct avenue for the transportation of supplies and the finished articles. Such a combination was ideal and the early colonists took full advantage of it in the development and prosecution of this business.

Beginning about 1700 the bog iron industry slowly developed and expanded so that during the Revolution and the War of 1812 several of the furnaces and forges played most important rôles. In the first decade of the 19th century further expansion took place with the result that this business reached its peak from 1812 to 1840. Its growth was slow and steady; its decline was precipitous and phenomenal. In eight years, 1846–54, this industry passed out of existence, never to be revived. Since then it has been forgotten; the furnaces and forges were abandoned—some in ruins, most of them destroyed—the iron towns melted away, later to decay and burn, and the forest came back to reclaim its own.

The collapse of this flourishing business was brought about primarily by the discovery in Pennsylvania of anthracite coal in the immediate vicinity of the great iron ore deposits. Furthermore, the bog ore was high in sulfur and phosphorus which, with the then-known methods of smelting, rendered it unfit for steel. These two facts above all else doomed the bog ore as a commercial source of iron.

When speaking of the early iron industry of New Jersey it must be divided

into two parts from two different angles: its mineralogical source and its geographic location. The State of New Jersey may be divided by a general northeast-southwest line extending from Asbury Park to Salem. North of the line is the Piedmont Plateau and the iron exists as magnetite and some hematite; south of the line is the Coastal Plain and the iron exists as limonite or bog ore. There are a few small deposits of bog ore north of the line but they are so unimportant as to be largely neglected and their presence is of interest primarily to the geologist. In the Coastal Plain there are two main areas of limonite beds, and several smaller sections. The bog ore occurs where the drainage of the land is very poor; *i. e.*, where swamps abound and very sluggish streams exist. Above tide water Cedar Creek falls 7 feet in 7 miles; Mullica River, 5 feet in 16 miles; Great Egg Harbor River, 5 feet in 25 miles. This condition is typical of South Jersey. Much of the land has very slight elevation and some of the swamps and forests are just about at sea level. The major bog ore deposits are in the basins of the Mullica River and Great Egg Harbor River systems. Other large deposits dot the headwaters of the North and South Branches of the Rancocas Creek. Minor deposits exist throughout the entire section. Reference to the list of furnaces and forges (page 1502) and to the map (page 1501) gives a very clear idea of the area over which this industry extended.

The literature on the formation of bog ore in the various parts of the United States is very voluminous. An attempt will be made to give a brief account of its formation in New Jersey.

In general there are two main mineral sources of iron in South Jersey; marls or greensands and the white sands. The former contains iron as a constituent with admixed iron pyrites and vivianite as impurities; the latter contains iron in its inferior layers in some form. There are several primary agents which decompose these ferruginous materials. Surface and underground waters charged with carbon dioxide and oxygen, with traces of sulfuric acid from the oxidation of pyrite, with many organic acids of complex and unknown character from the decay of vegetable matter, act on the iron-bearing substances. The iron slowly goes into solution probably as ferrous bicarbonate, ferrous sulfate, and ferrous salts of organic acids. A secondary reaction is that of the sulfuric acid on the greensands, limestone, and vivianite. Whatever are the intermediate reactions the net results are the same: the iron in solution.

The soluble ferrous salts are in a very unstable condition. The water slowly gives up carbon dioxide and the oxygen of the air oxidizes the iron which gradually precipitates as basic salts or hydrated oxides. Another very important oxidizer and coagulant of iron salts is the microörganism, crenothrix; particularly so in waters which are high in iron and organic matter. This filamentous bacterium oxidizes and precipitates the iron

about any firm object upon which it can cling. Deposits which have been made in this manner have taken the exact form of tree stumps, trunks, branches, and root systems.

The large streams are fed by the surface and underground waters and by the smaller streams; all these contain iron in solution. It is along the banks of these streams and swamps that the iron precipitates and builds up the beds of limonite. If in its precipitation the iron carries with it much mud, sand, and organic matter, there results a hard, compact rock commonly called ironstone. The limonite is indefinitely termed a hydrated iron oxide. Five such mixtures have received names as mineral species; only one, goethite, is recognized as definite. The others are considered to be amorphous and regarded as mixtures of the monohydrate with absorbed capillary water.

The general method of digging and handling the ore was essentially the same at all the works. Therefore, the method which was used at the Atsion Furnace is described in some detail.

The Atsion River takes its origin within a mile of Berlin (formerly called Long-A-Coming). Its course passes through an extensive ferruginous sand region, thence through cedar swamps, and finally to the swamps and meadows which border the pond at Atsion. In the manner described the water collects the iron in a soluble form and then deposits it in the bogs and meadows. This ore which was used at the Atsion works was dug three or four miles above the furnace and floated to it from the bogs on barges. The swamps were and still are very widespread and the numerous shallow coves at their edges were covered with water from one to two feet deep. Some, however, were filled with a spongy peat commonly called "muck," which was of little use. The ore was chiefly dug in these coves. Excavations eight to ten feet square were made and between each a thin dike or dam was left to prevent the water from flowing in upon the diggers or ore raisers. There were three kinds of ore which were generally found in each hole in the order named: the loam ore, the seed ore, and the massive ore. In some of the diggings only one or two of the varieties occurred, depending on their age. The loam ore was the youngest; it was merely the infiltration of the iron precipitate into the soil or loam of the bog. As it aged and was built up the ore became more compact and heavy. In the center of many of the lumps, the mass possessed a crystalline structure which, if permitted to age, would have been completely replaced by iron oxide. Even though the change was complete, or nearly so, the mass had a honeycomb or sieve-like structure. That which was partly changed from the loam to the seed ore was greatly preferred by the furnace operators because it was the best for easy reduction.

The handling of the raw products in the iron industry was very crude. Usually when the colonists made a clearing much of the timber was fired.

On the whole this was not the case in the neighborhood of the furnace. Immense quantities of charcoal were needed so that as the iron ore demanded this reducing agent, the land for farms, villages, and roads was cleared without undue waste. (It must be borne in mind that only the destructive distillation of wood was practiced.) The charcoal[1] and timber were hauled by mule and ox teams, and, as has been pointed out, the ore was generally floated to the furnaces. The flux seems to have been oyster and clam shells. Whether some of the furnaces used the limestone of marine origin which abounds in South Jersey is at present unknown. The ore, charcoal, and shells were mixed together and fired under a forced draft. The latter was produced by water power which will be more fully discussed soon.

The bloomaries and forges which were used in South Jersey were not different from those in the other colonies. All the types of bloomaries and forges originated in Europe and from them were designed those which were used in the colonies. The Anglo-Saxon word 'blooma' means a mass or lump and it is from this word that bloomary is derived. It signifies the furnace because the products derived from the heated ore were obtained in a lump or bloom. Properly speaking, the bloomary was a forge which converted the iron ore directly into wrought iron. The German bloomary which was used in the colonies was an enlargement and modification of the Catalan Forge.

In "The Forest of Dean," Nicholls quotes a description by Dr. Parsons of the furnace and forge which were used in England in the 17th century. The original manuscript was written in 1680. The description is given in part:

> From these furnaces they bring the sows and piggs of iron, as they call them, to their forges; these are of two sorts, though they stood together under one roof; one they call their finery and the other chafers; both of them are upon hearths upon which they place great heaps of sea coal, and behind them bellows like those of the furnaces, but nothing near so large. In such finerys they put their piggs of iron, placing three or four of them together behind the fire with a little of one end thrust into it where softening by degrees they stir and work them with long barrs of iron till the metall runs together in a round mass or lump, which they call an halfe bloom: this they take out, and, giving it a few strokes with their sledges, they carry it to a great weighty hammer, raised likewise by the motion of a water wheel, where applying it dexterously to the blows, they presently beat it into a thick short square; this they put into the finery again, and, heating it red hot, they work it under the same hammer till it comes to the shape of a barr in the middle, with two square knobs at the ends; last of all they give other heatings to the chaffers and more workings to the hammers, till they have brought their iron into barrs of several shapes, in which fashion they expose them for sale.
>
> All their principal iron undergoes the aforementioned preparations yet for several

[1] The author has it on good authority that charcoal is still made in the Jersey woods as it was made over a hundred years ago. Several wagon loads are brought out each year according to this report.

other purposes as for backs of chimneys, hearths of ovens and the like, they have a sort of cast iron, which they take out of the receivers of the furnace, so soon as it is melted, in great ladles and pour into the moulds of fine sand in like manner as they do cast brass and softer metals; but this sort of iron is very brittle that, being heated, with one blow of the hammer it breaks all to pieces.

The furnaces which were used in America were without a doubt an exact counterpart of those which were used in England at the same time. Another interesting description can be found in a "Collection of English Words" by John Ray, 1672.

The hammers, as has been briefly mentioned, were driven by water power. In Agricola's "De Re Metallica" printed at Basle in 1556 are engravings which show the tilt hammers and bellows which were used in Saxony. The basic ideas of these were brought to this country and developed. Again quoting from the manuscript just mentioned:

....Behind the furnace are placed two high pairs of bellows whose noses meet at a little hole near the bottom; these are compressed together by certain buttons placed on the axis of a very large wheel, which is turned round by the water, in the manner of an overshot mill. As soon as these buttons are slid off, the bellows are raised again by a counterpoise of weights, whereby they are made to play alternately, the one giving its blast while the other is rising.

In the same manner the wheel and trip hammers were operated for hammering the iron. Another description of the water blast or trompe appeared in the "Manufacturer's Guides" of 1858. It follows:

The water blast consists of a box, say 5 by $2^1/_2$ by $1^1/_2$ feet, nearly immersed in the stream, directly underneath the forebay or flume. The water rushes down into its upper end from the forebay through a wooden pipe, 8 inches square, separated in two by a space of an inch or two, as if the two joints of a stove pipe had parted that much. Into this slit air is sucked by the falling water and driven out through another 3-inch tube at the lower end. Inside the box, and parallel with its lid, a plank called the spatter board is set a few inches below the first tube. The water escapes from a hole under the water level at the lower end of the box. This apparatus gives a cold damp blast, with a great waste of water, but one that is very uniform.

The first type of furnace which was constructed in New Jersey and in all probability in other localities, too, was most unique and primitive. For this description the author is indebted to Mr. Wm. S. Pettit of Burlington, N. J., whose several ancestors were ironmasters at Atsion, Weymouth, Mary Ann, and Hanover Furnaces. This picture has been handed down by word of mouth so that the description may not be accurate as to dimensions and details, but the main facts and plan are substantially correct.

In the production of iron from the ore there must of course be material from which to build the furnace. In many cases the locations of the works were in the dense woods—brick and iron were necessarily absent and hard to get; timber, water power, and clay were in abundance. Mak-

ing use, therefore, of the material in hand the first furnaces were in many cases large gum trees, hollowed out and lined with clay. The hearth was of clay a foot thick, and at intervals of a foot or so above the hearth there were three sets of tap holes. The lower set was used to drain off the molten iron into a clay trough built around the tree trunk. This trough had a small spout through which the molten metal dropped into a little cart lined with clay. From this cart the iron was poured into sand moulds.

The second set of tap holes a foot or so above the first set was to draw off the slag into wheelbarrows or carts, likewise lined with clay. The tuyères were above this set of tap holes. During operations the holes were stopped with clay or hardwood plugs.

The air blast was produced by bellows, at first by man power and afterward by the ever-present water wheel. The air line which was later made of iron pipes was first made of wooden pipes with, in all probability, leathern joints.

The charging of the furnace was quite ingenious. An inclined plane was built against the tree and a cart loaded with ore, flux, and charcoal was drawn up. A rope was hitched to the cart, passed up the plane, then through a block down to the ground and through another block to the source of motive power. This was either horse power, ox power, or man power.

After a considerable quantity of pig iron had been made, a furnace of more rigid and permanent construction was built. From the clay bricks were made which were also used in the building of the furnace. This crude type of furnace gave birth to the iron industry of South Jersey.

It is commonly thought that the bog ore was only dug as a source of iron. This was not the case. One of the earliest and most unique uses of the ore was for war paint. The Indians ground the ore and mixed it with bear's grease and applied it to their bodies. There is no evidence that they knew how to reduce it to metal. The colonists used the ironstone for a great variety of purposes. Foundations of buildings, cellars, springhouses, smokehouses, retaining walls, bridge approaches, and millrace ways were built of this stone. The Arney's Mount Meeting House built in 1775 and the Mount Laurel Meeting House built about 1840 offer two excellent examples of the ironstone construction. The ruins of the paper mills at Weymouth and those at Harrisville are of bog ore; indeed, the extensive ruins of the latter show to the best advantage the various uses of the bog ore.

The growth of the iron industry in the colonies as a whole, of which the Province of New Jersey was an important part, gave England much anxiety during the 18th century. As early as 1729 came the first rumblings of trouble over iron. The following is an extract of a letter from the agent, Richard Partridge, of the Province of New Jersey.

London
The 21st of the 2nd Month, 1729

There is at this time a bill pending in the House of Commons..... ..... And also a Clause in said Bill prohibiting the maintaining and erecting any Iron Forges for making Bar Iron or Iron rods, that they might send over their Sows and Pigg Iron here; etc.

The Pennsylvania Gazette
The 17th of the 5th Month, 1729

Nothing seems to have come of this, but twenty years later a very definite step was taken against the iron industry in the colonies. The law was formulated in 1749 and printed and distributed in 1750 This law provided that

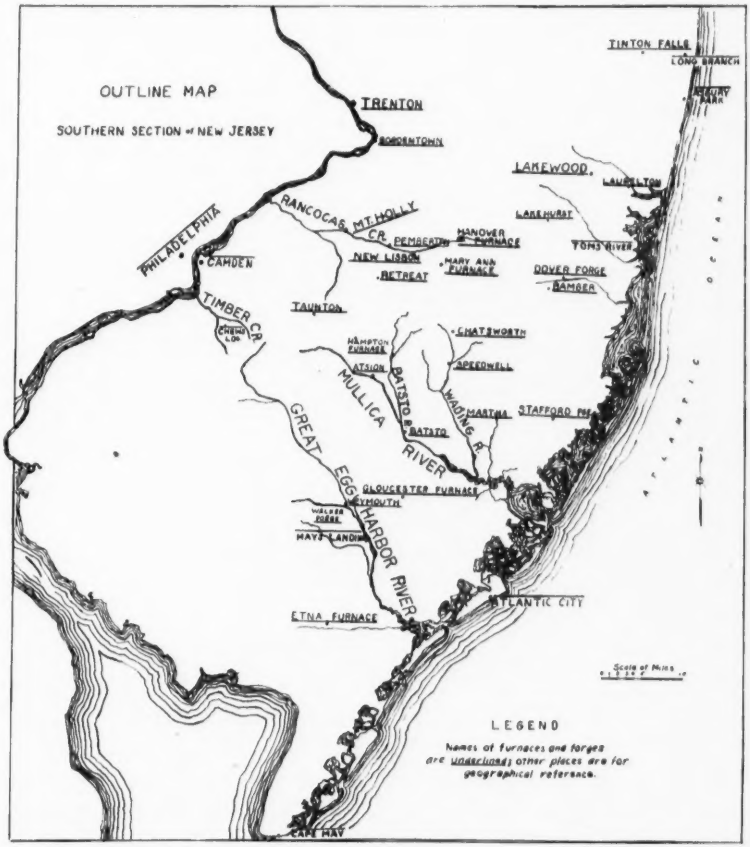
....Whereas, The importation of bar iron from His Majesty's colonies in America into the port of London and the importation of pig iron from the said colonies, into any port of Great Britain, and the manufacture of such bar and pig iron in Great Britain, will be a great advantage....that from and after the twenty-fourth day of June, one thousand seven hundred and fifty, the several and respective subsidies, customs, impositions, rates, and duties, now payable on pig iron made in and imported from His Majesty's colonies in America, into any port of Great Britain, shall cease, determine, and be no longer paid; ....(similarly for bar iron). And, that pig and bar iron made in His Majesty's colonies in America MAY BE FURTHER MANUFACTURED IN THIS KINGDOM, be it further enacted by the authority aforesaid, that from and after the twenty-fourth day of June one thousand seven hundred and fifty, no mill or other engine for slitting or rolling of iron, or any plateing forge to work with a tilt hammer, or any furnace for making steel shall be erected, or after such erection continued in any of His Majesty's colonies in America; .....

And it is hereby further enacted by the authority aforesaid that every such mill, engine, forge or furnace so erected or continued, contrary to the directions of this act, SHALL BE DEEMED A COMMON NUISANCE, ...

The clause, which allowed the importation of pig and bar iron duty free, was fostered by national necessity. The charcoal forests in England were rapidly becoming depleted and as this was the only means at that time of reducing the iron ore, the future in England looked very dubious for the manufacture of iron goods. Therefore, to stimulate the iron industry at home, as well as to protect it, the above law was passed. With the abundance of cheap raw materials and unlimited water supply the colonies were producing the iron and iron products cheaper than the mother country. The law was met with great indignation in the colonies and many letters and resolutions of protest were sent to Parliament, but to no avail. The law was strictly adhered to for a number of years but as the break between England and the colonies approached new furnaces and forges slowly appeared.

It is not the purpose of this paper to give a complete detailed life history of each of the ironworks in South Jersey. Such a story would soon become tiresome as a great similarity exists among the furnaces. Much

of the information of the various works has been lost and much that remains has become so garbled and twisted with time that it is not only unreliable but also fanciful. Several of the forges and furnaces are discussed in detail which with the exception of the local color gives a fair



MAP SHOWING LOCATION OF FURNACES AND FORGES IN SOUTHERN NEW JERSEY

idea of the others.[2] The ironworks in the list on page 1502 are given in chronological order of their construction.

[2] In the newspaper there are many notices for help wanted, runaway slaves, furnaces and forges for rent and sale, castings for sale, etc. Several typical notices will be given.

1674	Tinton Manor Works on the Shrewsbury River
1716	Imlaystown Forge
1722	Trenton Forge
1725	Bordentown Forge
1730	Mt. Holly Rolling Mill and Forge
1730	New Lisbon Forge
1767	Atsion Furnace and Forge
	Taunton Forge
	Batsto Furnace
1768	Etna Furnace (at Medford Lakes)
1773	Cohansie Ironworks
1787	Pemberton and New Mills Forge
1789	Dover Furnace
1793	Mary Ann Furnace
	Martha Furnace
1795	Hampton Furnace
	Speedwell Furnace
	Hanover Furnace
1797	Stafford Forge
1800	Weymouth Furnace and Forge
	Etna Furnace on the Tuckahoe River
	Monmouth Furnace
	Union Forge
	Birmingham Forge (later relocated at Retreat)
1808	Butcher Forge on the Metadeconk River
1809	Dover Forge
	Wading River Forge
1810	Ferrago Forge
1813	Gloucester Furnace, present site of Egg Harbor City
1814	Washington Furnace, now Lakewood
1816	Milleville Furnace
	Walker Forge
1820	Phoenix Furnace

In addition to these furnaces and forges which operated on a comparatively large scale, many of the colonists dug ore on their own property and either transported it to the furnaces and sold it or attempted in a very small and crude way to reduce it themselves. Others who owned deposits of the ore rented the land for a period of years so that the ore might be dug. The accounts of two such small enterprises are given. In an old family history and record book there is this statement:

> Moses Pettit purchased 250 acres below Black Creek, Bordentown, on Laurel Run, a tributary of Black Creek. He built a spillway and made iron from bog ore from 1696 to 1718.

Further than this there is no record. From an advertisement in the *New Jersey Journal*, November 30, 1779,[3] we have this account:

> To be LET for a term of years by
>
> GARRET RAPALJE
>
> at Squire's Point
>
> A valuable forge, with four fires, and two hammers, all in good order, and never wants water in the dryest season; lieing at the head of Muskenycunck River about eight miles from Hanover Furnace, where the best pigs can be had for making steel; there are seventy acres of very good meadow land.

The first iron furnace of which there is definite record in the Province of New Jersey was built at Tinton Falls on the Shrewsbury River by Henry Leonard about 1674 for James Grover. The works on completion

[3] This date is not in accordance with the alleged date of the construction of the Hanover Furnace, 1795.

THE HANOVER FURNACE, SHORTLY AFTER IT CLOSED DOWN

were sold to Colonel Lewis Morris to whom on October 26, 1676, the grant of ore rights was made by the Proprietors which gave to him and his heirs full liberty

> ....to dig, delve and to carry away all such mines for Iron as they shall find or see fit to dig and carry away to the ironworks.

The tract comprised about 3540 acres and to work it Colonel Morris is said to have employed sixty or seventy negroes.

At Mt. Holly there was located an ironworks which operated about fifty years. It was built in 1730 by Isaac Pearson, Mahlon Stacy, and John Burr who bought jointly 340 acres on the south side of the Rancocus Creek. The works passed through several owners, finally coming to Thomas Mayberry, or Maybury, just before the Revolution. The plant served the Continental Army with supplies of war, particularly cannon and shot. In May, 1775, Congress ordered five tons of sheet iron to be made into stoves and kettles for the Army. The works continued to operate until June of 1778 when they were destroyed by the British Army on its retreat from Philadelphia to Sandy Hook. The following notice of its destruction appeared in the *New Jersey Gazette* of June 24, 1778, which did not appear until July 8, 1778, because of the presence of the British troops.

> Trenton, July 1, 1778
>
> The enemy on their way through Burlington County wantonly destroyed a very valuable merchant mill near Bordentown, and the ironworks at Mt. Holly, and the dwelling, outhouses, etc. of Peter Tallman, Esq. and Colonel Shreve.

The following notice is also of interest:

> Wanted at Mt. Holly ironworks, a number of FORGEMEN and NAILORS, to whom the best wages will be given and constant employment. None need apply but those who can bring good characters with them. A few wood cutters are likewise wanted, to whom three shillings and ninepence per cord will be paid for cutting; The wood is chiefly pine and maple. For further information apply to Colonel Cox in Philadelphia or the subscriber at the works.
>
> Mount Holly, May 24. Richard Price
>
> (*Pennsylvania Evening Post*, May 27, 1777)

Sixteen miles east of Mt. Holly is the site of the Hanover Furnace, one of several ironworks owned and operated by the Fighting Quaker, General John Lacy. The furnace was built about 1790 and continued in operation for fifty years.

During the War of 1812 much cannon and shot were cast there in addition to the usual castings. There is nothing left of the furnace proper. The major portion of the slag pile remains, which covers approximately 16,000 square feet and contains some 6000 cubic yards. At a short distance from the slag pile and on the opposite side of the raceway are the

Site and Ruins of the Speedwell Furnace

remains of the charcoal dump which is entirely overgrown with underbrush and small trees.

Between Mt. Holly and the Hanover Furnace were three small ironworks, the New Lisbon Forge built by John Earle; the Mary Ann Furnace built by Benjamin Randolph of Philadelphia, and Lacy's ironworks at Pemberton.

The other interests of the "Fighting Quaker" were on the upper reaches of Cedar Creek in Ocean County. He built a forge at Ferrago, later called Bamber, which continued in operation after the native ore ran out. Tradition says that ore was brought by boat from Orange County, New York, to Forked Road; from there the ore was carried by mule team over Lacy's Road to the furnace at Bamber for smelting. It was returned to New York as pig iron. The General also built a small furnace at Dover not far from Bamber.

There were several other small furnaces in this general vicinity, which should be mentioned in passing. Lakehurst had its birth as an irontown. The Federal Furnace was built there by Caleb Ivins and David Wright. Not far away is Lakewood where Jesse Richards built a furnace in 1814 and called it Washington Furnace. Twenty years later he sold the works to J. W. Brick who renamed it the Bergen Ironworks. Several miles be-

low Lakewood on the Metadeconk River J. Lippincott of Mt. Holly built the Butcher Forge in 1808. It was later called Burrsville and now Laurelton.

Somewhere between 1793–5 the Speedwell Furnace was built by Joseph Walker and John Youle on the west branch of the Wading River. These men leased the ground from Ann Randolph who in 1833 conveyed the tract to Samuel Richards. Once again it must be said that there is nothing left of the old furnace except a few timbers and parts of the foundation of the cupola, the slag pile, and the charcoal dump. Both of the latter are completely overgrown with underbrush and trees. Originally attached to this furnace were ten thousand acres of land.

Seven or eight miles south of Speedwell on the Oswego or East Branch of the Wading River is the site of the Martha Furnace. This district, judging from visual evidence, records, and hearsay must have been very busy and industrious. If it is possible to say that one section of the Pines is more desolate, more forsaken, and more forbidding, the Martha Tract is that and more. Not a sign or sound of civilization or human life, deer tracks through the woods and through the sites of former gardens and cultivated lands, and a road which is slowly being swallowed by the encroaching swamps combine to give this region the aspect of complete desolation.[4]

The Martha Furnace was one of the largest and most important of the furnaces of that district. Connected with the furnace and its 60,000 acres of land was a large grist mill of which nothing remains but the two stone wheels in perfect condition and a saw mill which was built in 1758 by Jonathan Hough. A mile or so above the furnace there was a brick yard, and again it must be repeated—nothing left. The furnace and forge are in complete ruins, covered over with the debris of years and overgrown with underbrush and trees. Over the doorway of the cupola there was an iron plate with the legend, "Isaac Potts, 1793." This disappeared a long time ago, before the furnace fell in ruins. Two of the trip hammer heads, weighing, according to hearsay, 500–700 pounds, were removed from the ruins of the forge about the time of the Spanish-American War and sold for scrap iron.

A dam and retaining embankment held back the river which provided power for the grist mill and the ironworks; the former was situated at the channel, and the latter some two hundred and fifty feet distant. Where

[4] The daily newspaper accounts of the forest fires in New Jersey during the first few weeks of May are probably still fresh in the reader's mind. Following is an excerpt from a recent letter of the author: "These fires covered almost two-thirds of the district which is described in my paper. I was on the fire lines myself and saw some of it at its worst. Several of the small towns, hamlets, and landmarks were wiped off the face of the map. I described that district as desolate—it is now indescribable in its complete nakedness. One of the game wardens told me that from one section of his district over two five-ton truck loads of dead deer were taken from the woods."

the dam joined the easterly bank was the raceway and the forge. Judging from present conditions the raceway was six to seven feet wide and the water had a head of five to six feet. The dam was faced with ironstone filled in with earth and slag. There are enormous quantities of the latter everywhere to be seen; in the marshes, in the road beds, and in the streams at fording places.

As it may be inferred from a previous statement, Isaac Potts built the furnace in 1793 and named it in honor of his wife, Martha. In the original journal of Isaac Potts is the following entry:

> 9 mo. 29 10 o'clock a.m. Martha Furnace went in Blast, made the first Casting 30th at 3 o'clock in the morning, 1793.

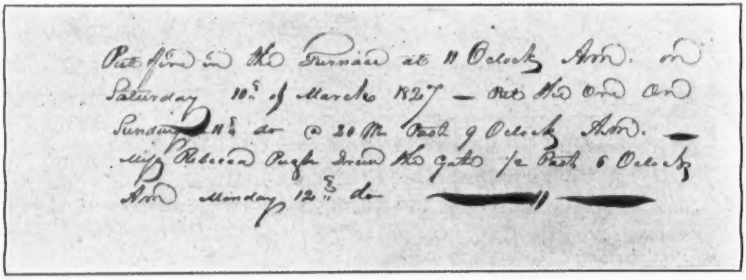
and after this notation there follow other similar ones together with the record of the sale of pigs and castings which consisted of hollow ware, stoves, "cambooses," kitchen hearths, fire backs, and jambs. After the furnace was well under way Isaac Potts moved to Philadelphia and lived on Arch Street between Sixth and Seventh Streets. He continued the operation of the furnace for a number of years. About 1808 the ownership of the furnace came into the hands of Joseph Ball and Samuel Richards through the men who built and operated the Weymouth Furnace. In 1841 the latter conveyed the works to Jesse Evans and a few years later the furnace and forge shut down.

In passing it may be of interest to note that Isaac Potts owned the house which was used by General Washington as headquarters at Valley Forge. Potts also owned and operated the grist mill at the same place and John and Joseph Potts owned the Mount Joy Forge or as it is better known, Valley Forge.

Weymouth, whose port was May's Landing, was situated about six miles above navigation on the Great Egg Harbor River, and sixteen miles directly south of Batsto. The ironworks were built in 1800 by Charles Schoemaker, George Ashbridge, Morris Robeson, and John Paul who had bought from the West Jersey Society the Great Egg Harbor Tract of 80,000 acres. The furnace was on the site of the ruins of the paper mill which may still be seen. The furnace was built of ironstone lined with brick, thirty feet square at the base, thirty feet high and fifteen square at the top; the circular opening at the top was eight feet in diameter. The Great Egg Harbor River had been dammed and this furnished water power to operate the trip hammers and bellows. The air blast was kept up by these bellows which were driven by a five-foot water head through pipes connected by leathern sleeves. Large iron tanks were used as an air reservoir to maintain a steady pressure. Over a ton of iron a day was produced. The furnace opened in March (this was the usual time for all the furnaces) and operated the balance of the year. (See illustration on page 1508.)

Shortly after the construction of the works Samuel Richards purchased the entire tract and under his direction the plant expanded and flourished. His son-in-law, Stephen Colwell, probably influenced by Jacob Pettit, ironmaster, introduced the first six-day working week into the iron business. It was tried as an experiment with much misgiving, but after it was found successful the fires were shut down on Saturday night. One other man who contributed to the success of the Weymouth Furnace was the superintendent, L. M. Walker. He assumed charge of the works about 1810 and resigned about 1816. He then built his own forge at some distance from May's Landing, which he operated for a number of years.

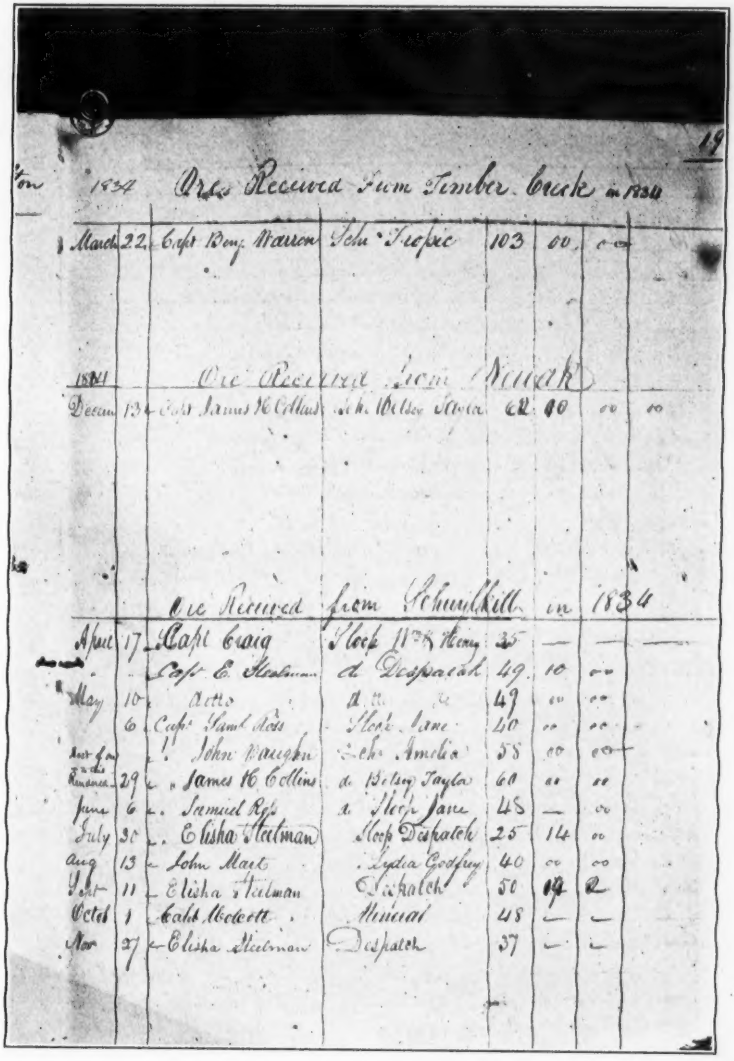
Proceeding from Weymouth to Elwood there runs parallel to the road on the west side for about a half mile the remains of the main canal with its laterals to the diggings, down which small barges were floated and poled by two boys or by a boy and a man. These barges carried the ore



NOTE IN DAY BOOK ON SPRING OPENING OF WEYMOUTH FURNACE

directly from the diggings to the furnace. In like fashion the finished products were loaded on flat boats and poled down the river to May's Landing where the freight was loaded on ships for transportation. About 1844 or 1846, only a few years before the furnace shut down, a track was laid through the woods to May's Landing. Several freight cars were built and this train was pulled by three or four pairs of mules. This greatly aided the transportation of the finished products from the furnace to the ships. Later a passenger car was added for the convenience of travelers.

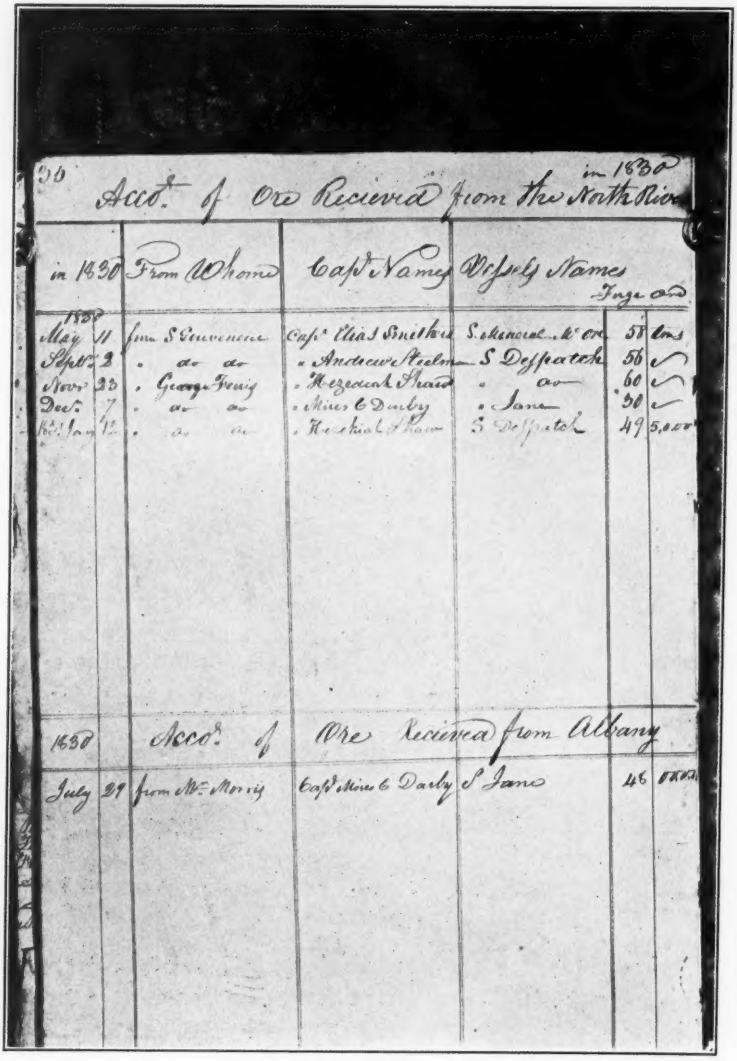
This furnace handled large quantities of its own ore as well as imported ore. Iron ore was brought from Staten Island, Peekskill, Albany, Bristol, the Timber Creek district, the Schuylkill district, Smyrna, Delaware, and other points in that state. The ore was dug in small quantities along the upper reaches of Big Timber Creek and taken to Chew's Landing. There it was loaded on ships and taken to Weymouth for reduction. (Chew's Landing is on a branch of the Big Timber Creek and ships of sixty



			Ores Received from Timber Creek in 1834				
March	22	Capt Benj Warren	Schr Freejee	103	00	00	
1834		Ore Received from Newark					
Decem	13	Capt James H Collins	Sch Belsey Taylor	62	00	00	00
		Ore Received from Schuylkill in 1834					
April	17	Capt Craig	Sloop Wm Henry	35	—	—	—
		Capt E Stedman	a Despatch	49	10	00	
May	10	Attis	a [illegible]	49	00	00	
	6	Capt Saml Ross	Sloop Jane	40	00	00	
		John Vaughn	Sch Amelia	58	00	00	
	29	James H Collins	a Belsey Taylor	60	00	00	
June	6	Samuel Ross	a Sloop Jane	48	—	00	
July	30	Elisha Stedman	Sloop Dispatch	25	14	00	
Aug	13	John Mark	Lydia Godfrey	40	00	00	
Sept	11	Elisha Stedman	Dispatch	50	19	2	
Octob	1	Capt Malcott	Musical	48	—	—	
Nov	27	Elisha Stedman	Despatch	37	—	—	

From the Books of the Weymouth Furnace

Account of ores received in 1834.



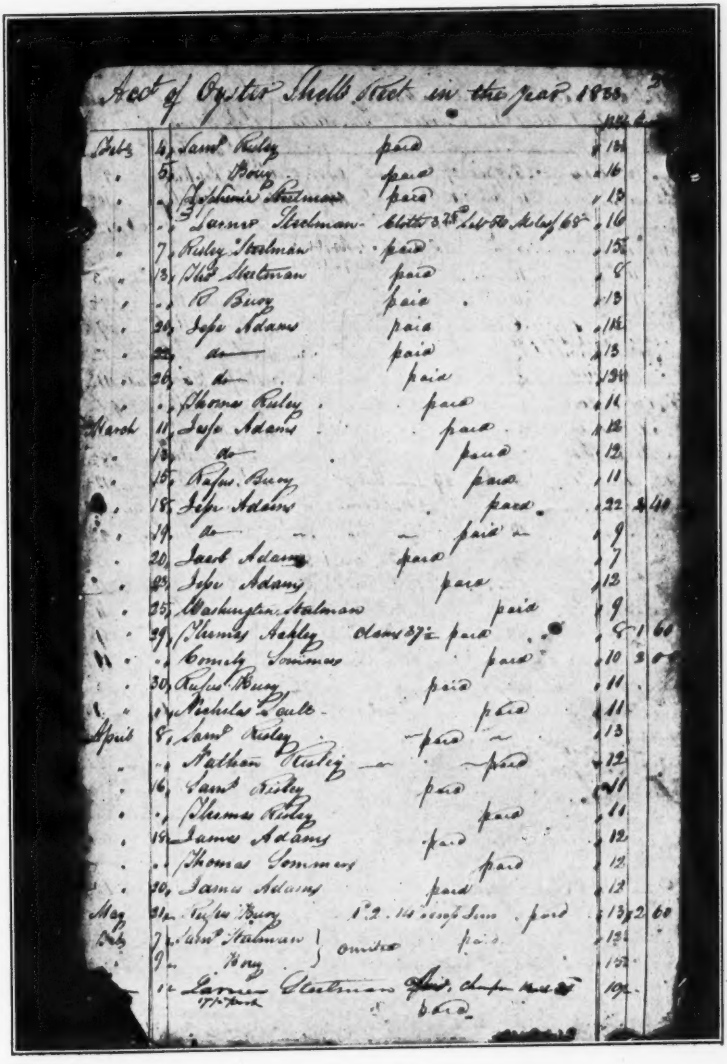
Acco.t of Ore Recieved from the North River in 1830

in 1830	From Whom	Capt.n Name	Vessels Names	Tons	Gross or Nett
1830				Tons	
May 11	from S.t Lawrence	Capt.n Elias Smith	S. Hancock & Co.	55	Tons
Sept.r 2	do do	Andrew Scalon	S. Despatch	56	✓
Nov.r 23	George Ferris	Hezekiah Strain	do	60	✓
Dec.r 7	do do	Miner C. Darby	Jane	30	✓
Jan.y 12	do do	Hezekiah Strain	S. Despatch	49	5,000

1830		Acco.t of Ore Recieved from Albany			
July 29	from Mr. Morris	Capt.n Miner C. Darby	S. Jane	46	Gross

FROM THE BOOKS OF THE WEYMOUTH FURNACE

Account of ore received in 1830.


Acct of Oyster Shells Rect in the year 1833.
Feb 4 Saml Risley paid
5 Benj Bury paid
Nathaniel Stedman paid
Saml Stedman 6 Bbls 3.25 1.50 Risley 68
7 Risley Stedman paid
13 Saml Stedman paid
R Bury paid
24 Jesse Adams paid
do paid
26 do paid
Thomas Risley paid
March 11 Jesse Adams paid
do paid
15 Ralph Bury paid
18 Jesse Adams paid 22 2.40
19 do paid
20 Isaac Adams paid
23 Jesse Adams paid
25 Washington Stedman paid
29 Thomas Risley Adams 37½ paid 1.60
Comfy Simmons paid 2.00
30 Ralph Bury paid
Nicholas Poole paid
April 8 Saml Risley paid
Nathan Risley paid
16 Saml Risley paid
Thomas Risley paid
18 James Adams paid
Thomas Simmons paid
30 James Adams paid
May 21 Ralph Bury 1.12 1.16 Long Sim paid 2.60
July 7 Saml Stedman 1 Omitted paid
Benj Bury
Laurence Stedman paid

FROM THE BOOKS OF THE WEYMOUTH FURNACE

Account of oyster shells received in 1833.

to eighty tons' register sailed from there. Now the creek is only large enough for canoes and rowboats.)

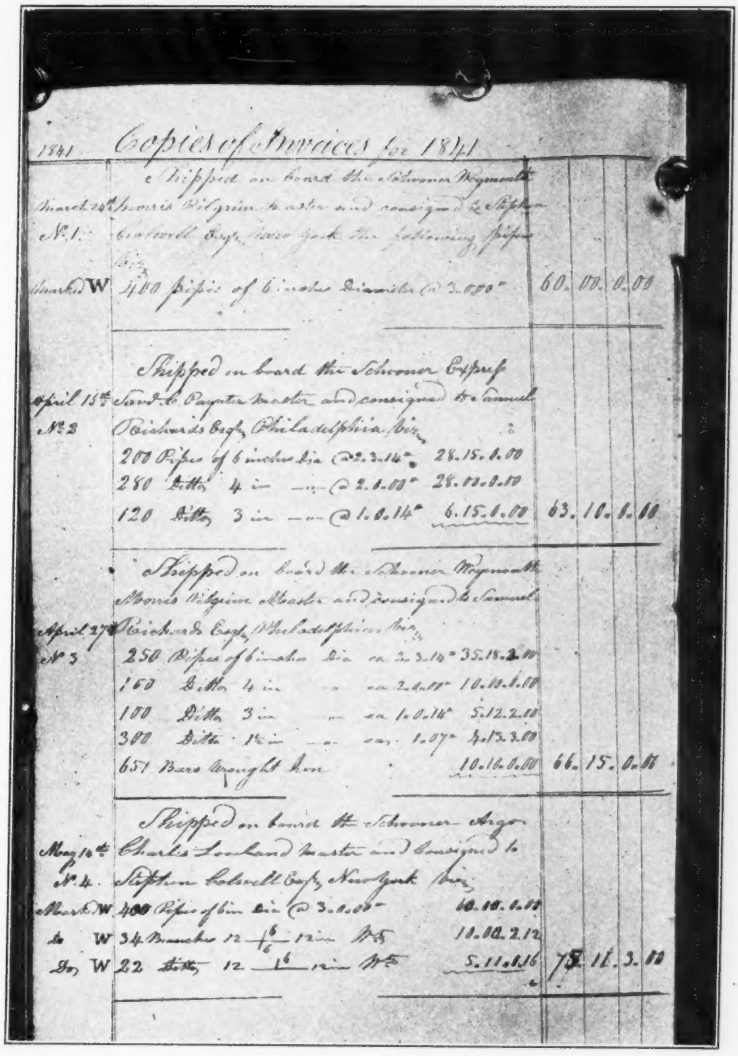
The first cast iron water pipes which were laid in the streets of Philadelphia as an experiment were cast at the Weymouth ironworks. In a letter of December 29, 1798, to a Select Council Committee, Benjamin H. Latrobe, chief engineer of the Philadelphia Water Works, stated that a "9-inch cast iron pipe might be substituted in place of the bored logs in the course of time." In a report to the Water Works of November 16, 1801, two employees of the works, Todd and Davis, made a very comprehensive report on water pipes in general. They gave the cost of 6-inch, $^3/_4$-inch wall, cast iron pipe as \$1.53 per lineal foot, or for fourteen lengths, \$128.52. In the report of the Committee of the Philadelphia Water Works under date of October 12, 1801, there is the item "due Robeson and Paul for iron pipe \$128.62." These two men were merchants located at 53 North Water Street, Philadelphia, and were part owners of the Weymouth Furnace. The pipes were laid near the Center Square Engine House, about the site of the City Hall. Todd and Davis further state that the cost of the pipe as laid was \$1.71 per lineal foot, also that "$4^1/_2$ inch need not, perhaps, be more than $^5/_8$ inch thick, making the cost (at the same rate per ton as the 6-inch) not more than \$$1.12^1/_2$ per foot, when laid, except repaving."

The second experiment with cast iron pipe seems to have been made in 1804 when 56 tons of 3-inch pipe were laid "in Water Street, Vine Street to the Drawbridge, and also in some other situations." The total payment to Robeson and Paul for this pipe from the report of 1804–05, was \$4367.22 or \$78 per ton. The report of 1804 gives the total distribution of pipe as wood—28,572 feet; iron—3978 feet. From then on cast iron pipe slowly displaced the wooden pipes.

It may be of interest to note that Mark Adams, a moulder and coremaker of reputation made the first pipes for Philadelphia at the Weymouth Furnace.

In 1817–18 iron pipes were imported from England, but as the American furnaces increased production this importation ceased. From 1820 on Samuel Richards supplied large quantities of pipes for the Philadelphia Water Works from the Weymouth Furnace which he owned. On pages 1512–3 are photographs of invoices of shipments of pipes to Philadelphia. With the demonstrated success of the cast iron pipe, other furnaces took up their manufacture and we have information that Benjamin Howell of the Hanover Furnace, Lawrence Saltar of the Atsion Furnace, and L. M. Walker of Walker's Forge made and shipped iron pipe for Philadelphia.

Batsto, one of the most important of the furnaces in the State during the Revolution, was situated at the confluence of five streams which form



1841 Copies of Invoices for 1841

Shipped on board the Schooner Weymouth
March 26th Morris Pilgrim master and consigned to Stephen
No 1. Colwell Esqr New York the following pipes
viz

Marked W 400 pipes of 6 inches Diameter @ 3.000 60. 00. 0. 00

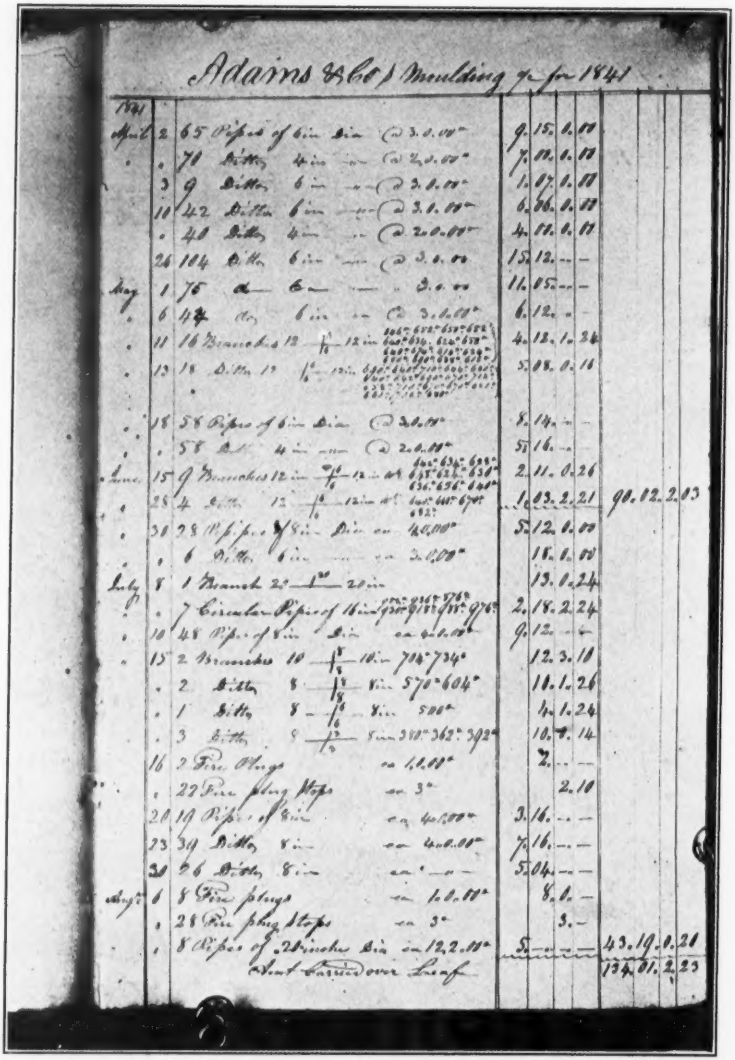
Shipped on board the Schooner Cygnet
April 15th Samuel Carter master and consigned to Samuel
No 2 Richards Esqr Philadelphia viz

200 Pipes of 6 inches dia @ 2.3.14 28.15.1.00
280 Ditto 4 in @ 2.1.00 28.11.0.10
120 Ditto 3 in @ 1.0.14 6.15.1.00 63. 10. 1. 10

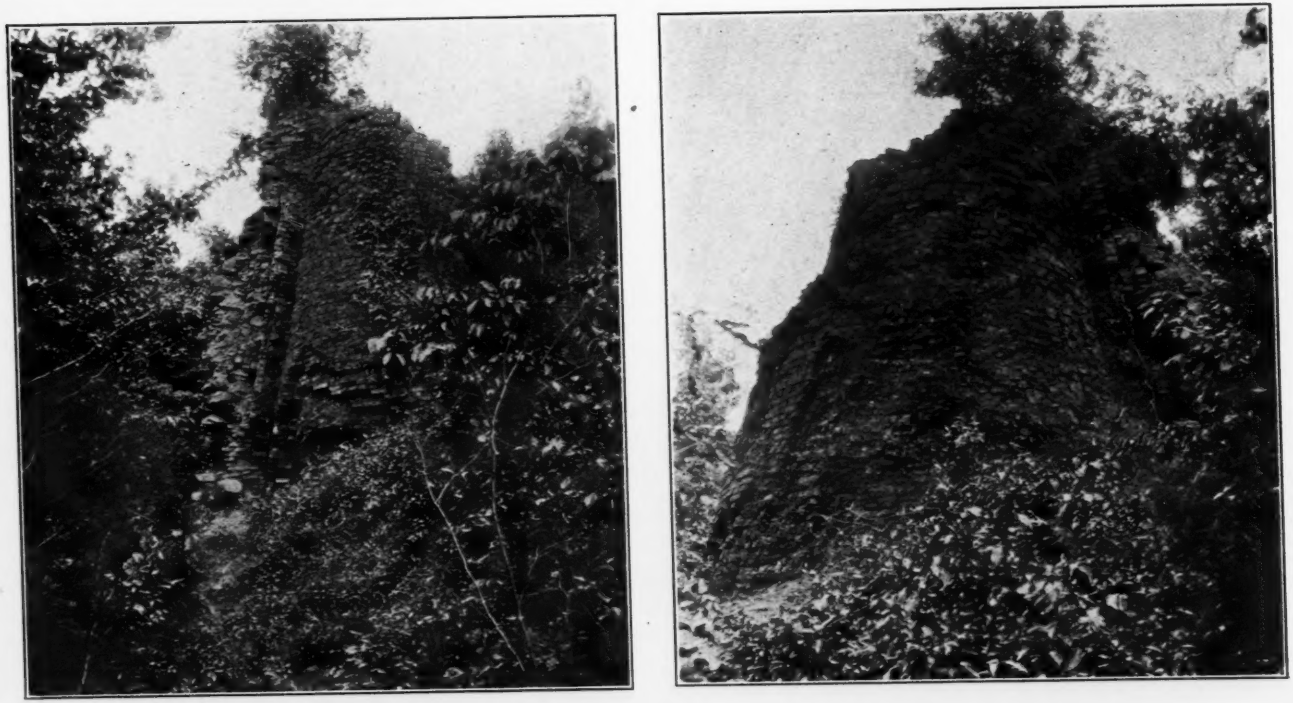
Shipped on board the Schooner Weymouth
Morris Pilgrim Master and consigned to Samuel
April 27th Richards Esqr Philadelphia viz
No 3 250 Pipes of 6 inches dia @ 2.3.14 35.18.2.10
160 Ditto 4 in @ 2.1.00 10.10.1.10
100 Ditto 3 in @ 1.0.14 5.12.2.10
300 Ditto 1½ in @ 1.07 4.13.3.00
651 Bars wrought Iron 10.14.0.00 66. 15. 0. 10

Shipped on board the Schooner Augt
May 18th Charles Lowland master and consigned to
No 4. Stephen Colwell Esqr New York viz
March W 400 Pipes of 6 in dia @ 3.1.00 10.10.0.00
do W 34 Branches 12 6/6 12 in Ms 10.00.2.12
do W 22 Ditto 12 6/6 12 in Ms 5.11.0.16 75. 11. 3. 10

PIPE SHIPMENTS FROM THE WEYMOUTH FURNACE



PIPE SHIPMENTS FROM THE WEYMOUTH FURNACE



ETNA FURNACE ON THE TUCKAHOE RIVER AS IT LOOKS TODAY

SIX-INCH CANNON BALL MOULD FROM BATSTO FURNACE

the Mullica River. The Indian names of the streams were Baastoo, Atseyunk, Machesautauren, Nescochageu, and Yacomanshag. From the name Baastoo, which means a bathing place, comes the present name Batsto, and from Atseyunk comes the name Atsion. The furnace was built for Charles Read in 1766–67 and six years later it was sold to Colonel John Cox and by him to Mr. Joseph Ball, a wealthy Philadelphia Quaker. The sale price of the works and the estate was said to have been $275,000, one of the largest real estate transactions ever made in the colonies. Mr. Ball rebuilt the works, dammed Batsto River to give more water power, and added a casting furnace as well as other improvements. At the close of the Revolution Wm. Richards owned the furnace and the entire estate of 50,000 acres. The furnace produced large quantities of shot, small arms, and cannon during the Revolution and the War of 1812. Not far from the Batsto Furnace was the Atsion Forge. These two furnaces produced such large quantities of munitions of war that an attempt was made by the British to destroy them. The military operations are a chapter in the Revolution and need not be repeated.

Of such importance to the colonies were these works in the State that the Assembly passed at Haddonfield on June 5, 1777, an act exempting

men employed in the works from military duty in the militia. The act also provided for the organization of a company of ironworkers not exceeding fifty under the command of a captain and two lieutenants to be named by Colonel Cox and commissioned by the Governor of New Jersey. Immediate advantage of this edict was taken as may be seen by the following advertisement which appeared in the *Pennsylvania Evening Post*, June 26, 1777.

Mount Holly in New Jersey, June 23, 1777.

Wanted at Batsto and Mount Holly iron works a number of labourers, colliers, nailores, and two or three experienced forgemen to whom constant employ and best wages will be given—four shillings per cord will be paid for cutting pine and maple wood. For further information apply at Colonel Cox's counting house on Arch Street, Philadelphia, to Mr. Joseph Ball, manager, at Batsto, or to the *Subscriber* at Mount Holly. Richard Price.

N. B. The workmen at these works are by law of this State exempt from military duty.

One year later the Continental Congress passed a similar act which applied to all the colonies. Governor Livington's message in which he communicated the order of Congress to the General Assembly of the State of New Jersey appeared in the *New Jersey Gazette*, June 3, 1778.

The Batsto Furnace at its height employed about 125 men and the town itself numbered a thousand souls. In addition to the Furnace, there was a glass works, large saw mill, a grist mill, and an independent charcoal business. Today there is nothing left whatever of any of the industries and the town has shrunk to a hamlet of a dozen or so small buildings.

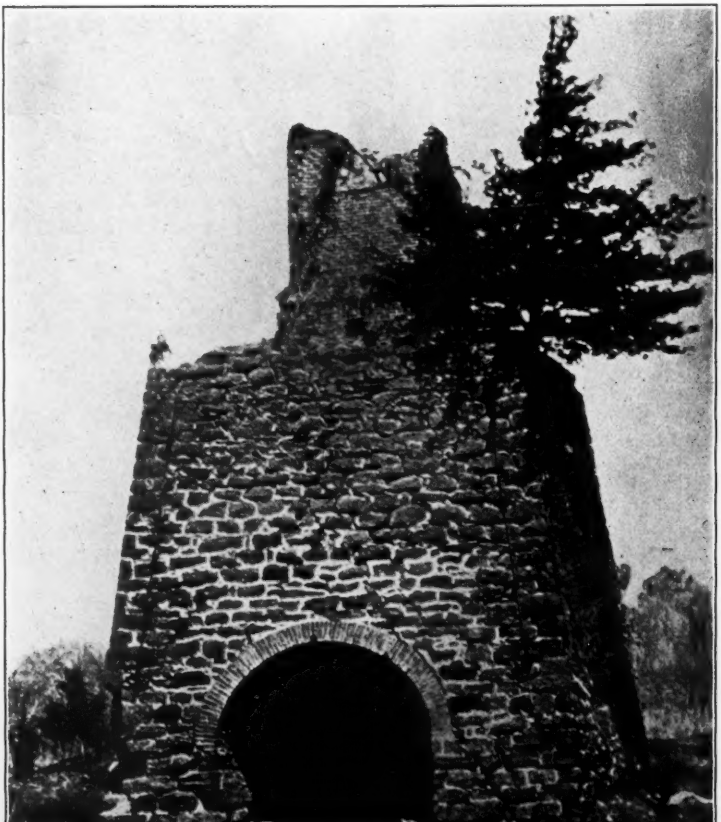
Among the other projects of Charles Read were the first Etna Furnace, the Taunton Forge, and the Atsion Furnace. The first two plants were near each other; the former near Medford Lakes, and the latter at Taunton but a few miles distant. The first Etna Furnace ceased operations during the Revolution but later reopened at Ballinger's Mills. The following notice is of interest.

At Etna Furnace in the County of Burlington good Colliers, two good Carpenters, a good Smith that understands the making of flatt or padd iron handles, a good stone Cutter, a person used to grid flatt irons and waggon boxes will meet with encouragement.

The Pennsylvania Journal, March 3, 1768

The Atsion Furnace has been briefly mentioned in connection with Batsto as well as in the above paragraphs. It was built by John Estell for Charles Read,[5] who later conveyed it to John Cox. In 1773 "all that land whereon Atsion Forge and houses were built" was conveyed to Able James, Henry Drinker, and Lawrence Saltar who subsequently formed the Atsion Company. It will be remembered that William Richards

[5] An Act of the Legislature June 20, 1765, empowered John Estell to erect a dam across the Batsto River to supply water power for a furnace and mill.



ETNA FURNACE ON THE TUCKAHOE RIVER AS IT LOOKED IN 1885
This construction was typical of the South Jersey furnaces.

became owner of the Batsto Furnace about 1784. With the formation of the Atsion Company there seems to have been trouble between the two furnaces. One altercation on the right to use and cut certain forest lands led to a law suit about 1794–95. About the same time a canal was dug at the direction of Lawrence Saltar which by-passed the waters of the Machesautauren River into the Atsion River. William Richards sued the Atsion Company stating infringements of water rights. The suit started in 1799 and was finally settled in the Court of Chancery at Trenton in 1801. This canal still functions and is called to this day Saltar's Ditch. The Company continued to do business until 1824 when the entire rights were sold to Samuel Richards. This was the only ironworks in South Jersey which employed Indians. It must be remembered that the large Indian Encampment at Edgepillock, now Indian Mills, was only a few miles distant.

Of the three ironworks which have just been mentioned there are two interesting notices in the *Pennsylvania Journal* of October 11, 1770, and January 17, 1771. They are full notices advertising for sale the Etna Furnace, the Taunton Forge, and the Atsion Works by Charles Read.

The author would greatly appreciate if such persons who have information of any of the furnaces would communicate with him about them. It can be easily seen that the data of many of the furnaces are meager and incomplete. Several of the furnaces were not described since there was nothing of importance about them; further descriptions would only add to the long list of meaningless ruins.

This short and incomplete history of the several furnaces clearly shows the extent of this industry one hundred and twenty-five years ago. In 1854 the last South Jersey furnace shut down and in this brief span of seventy-five years practically the entire story of the bog ore industry has been destroyed or lost. It is the firm belief of the author as he has tramped the sites of these ironworks that if excavations were made, interesting ruins, relics, and possibly records would be found. Without blinking, an expedition for investigation and research in any field is sent to the "Land's End," while unnoticed at our doors are the foundations which made American history.

* * * * *

The writer wishes to take this opportunity to express his appreciation to the very many friends who assisted him in the preparation of this article. Particularly to Dr. R. H. Morris of Haddonfield, N. J., for his careful editing of the manuscript, to Mr. W. A. Thacher of Weymouth, N. J., for his inestimable aid in the entire project, to Mr. Alfred Rigling of the Franklin Institute of Philadelphia, to Mr. J. C. Trautwine, 3rd, of Wallingford, Pa., to Mr. Charles Bohmer of Ambler, Pa., and finally to Miss Grace Wood of Haddonfield, N. J., is the author greatly indebted.

THE GROWTH OF LEAD CRYSTALS IN SILICA GELS*

ROBERT TAFT AND JESSE STARECK, THE UNIVERSITY OF KANSAS, LAWRENCE, KANSAS

Doubtless many chemists at some time in their career have indulged in the recreation of growing lead crystals in silica gels. Few, however, have taken time to publish any observations on the growth of these interesting crystals. Simon[1] was apparently the first individual to record this phenomenon of growth. Somewhat later Holmes[2] pointed out that the most favorable concentration for large crystal growth was in a solution 0.02 *N* with respect to lead acetate. Brewington[3] and Stone[4] have described procedures for the growth of these crystals as a project for beginning classes. A more extensive study of the experimental factors determining the growth of these crystals has not been published as far as the authors are aware. Chiefly as a diversion we have grown some hundreds of specimens and as the results were interesting and in some cases quite instructive we present the more important ones herewith.

The experimental factors which we have varied are (1) the nature of reducing agent, (2) the concentration and composition of lead salt, (3) the hydrogen-ion concentration of the gel, and (4) the viscosity of the intercellular liquid present in the gel pores.

Procedures for growing these lead crystals may be found in the references listed above. Our procedure was to mix equal volumes of a sodium silicate solution (sp. gr. 1.06) with a mixture containing acetic acid and the lead salt so that upon mixing the two solutions the desired concentration of acid and of salt was obtained. The specimens were grown in test tubes (8″ × 1″) which were stoppered to prevent drying of the gel. A number of the specimens are shown in the accompanying photographs.[5]

The usual reducing agent used to cause precipitation of lead is zinc, although tin has been suggested. In addition to these we have tried such

* Read before the Kansas Academy of Science, Manhattan, Kansas, April 27, 1929.

[1] *Zeit. Chem. Ind. Kolloide*, **12,** 171 (1913).

[2] *J. Franklin Inst.*, **184,** 743 (1917). See also Holmes, "Laboratory Manual of Colloid Chemistry," 2nd ed., John Wiley & Sons, **1928,** p. 138.

[3] THIS JOURNAL, **6,** 2228 (Dec., 1929).

[4] *Ibid.*, **6,** 355–6 (Feb., 1929).

[5] Frequent inquiries as to our method of photographing these deposits have been made and for that reason the procedure is briefly described. The test tubes containing the crystals were placed against a large floodlight, the face of which was covered with several thicknesses of parchment paper to obtain diffuse illumination. A 100-watt lamp was used in this flood lamp. The specimens were thus photographed against a bright background, with no other illumination, the photographs being made in a dark room. They were photographed at 1/4 of their natural size on a cut film of par speed, using a very small stop (f 32) with long exposure. Enlarged prints of these negatives were then made by the procedure previously described by one of the authors. [THIS JOURNAL, **6,** 1928 (Nov., 1929).] While the photographs do not do the crystals justice, this method yields better results than the authors have seen elsewhere.

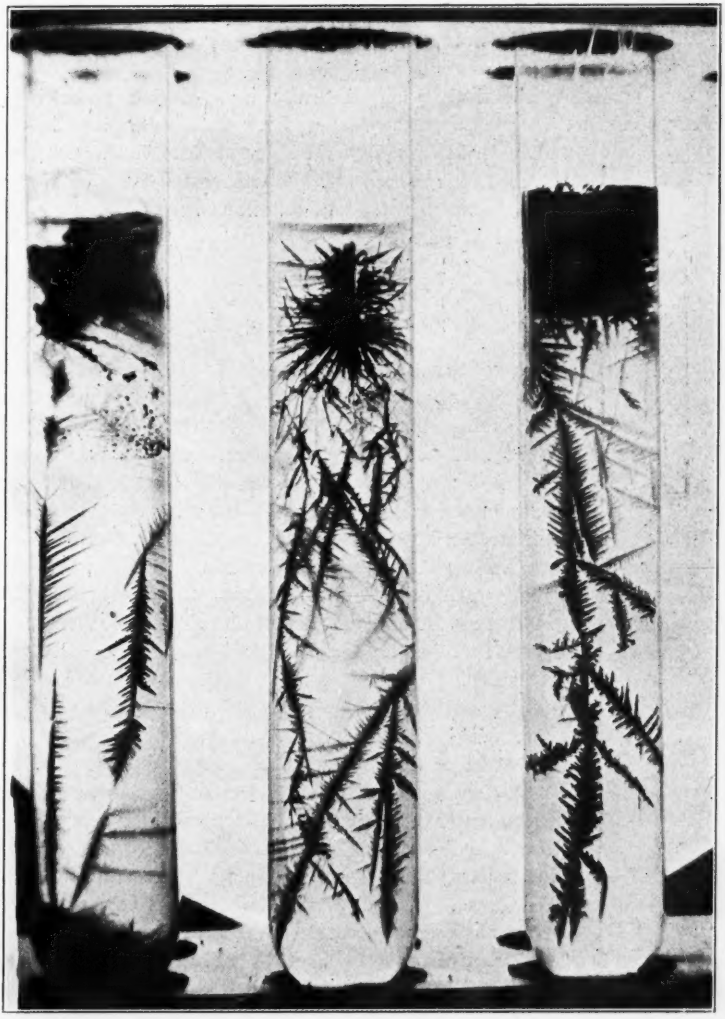


FIGURE 1

Reducing metal (left to right): Tin, cadmium, iron.
Concentration of lead acetate: 0.1 *N.*
Age: 3 to 5 weeks.
In the case where tin was used, the metal was added before gelation was complete and some of the metal sank to the bottom; consequently the trees are growing from both top and bottom.

substances as cadmium, calcium, manganese, aluminum, silver, chromium, nickel, cobalt, iron, thallium, magnesium, hydrogen, copper, lead, brass, and sodium amalgams.

From an electrochemical standpoint any half-reaction producing a lower potential than the potential existing between metallic lead in contact with lead ions would be capable of causing some of the lead ions to deposit. Consider the case of zinc as the reducing agent. The reactions involved may be indicated as follows:

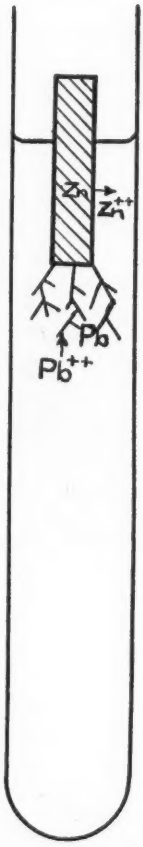


FIGURE 2

$$Zn - 2\epsilon = Zn^{++}$$
$$Pb^{++} + 2\epsilon = Pb, \text{ the net reaction being}$$
$$Zn + Pb^{++} = Zn^{++} + Pb.$$

For a concentration of zinc ions equal to 1 gram mole per 1000 grams of water the potential of the metallic zinc against such a solution would be approximately -0.76 volt[6] at room temperature. That of lead against a solution containing a gram mole of lead ions per 1000 grams of water is -0.12 volt. If we have a system such as indicated in Figure 2 the concentration of zinc ions is practically zero at the start and that of the lead ions may be any value desired up to that imposed by the solubility of the lead salt used; let us assume that its concentration is such as to make the Pb/Pb^{++} boundary -0.12 volt. The zinc ions having a lower concentration than 1 *M* will have a still lower potential than -0.76 volt[7] and consequently lead deposits. As lead deposits, the concentration of lead ion decreases (hence the potential Pb/Pb^{++} decreases) and that of the zinc ion increases (and consequently the Zn/Zn^{++} potential increases). This process will continue (provided that sufficient metallic zinc is used) until the two potentials are equal and will then cease. The concentration of lead ions, however, tends to remain constant due to the diffusion of the lead ions toward the crystals already formed and the growth of the lead crystals into the regions of higher lead-ion concentration. It is exceedingly important to notice the part played by the concentration of the

[6] Signs are used throughout in conformity with recommendations of the American Electrochemical Society.

[7] The student of electrochemistry will recall that increasing the concentration of a metallic ion reversible with respect to a given electrode will make the electrode potential greater, *i. e.*, more positive or less negative; decreasing the concentration of the metallic ion would have the opposite effect.

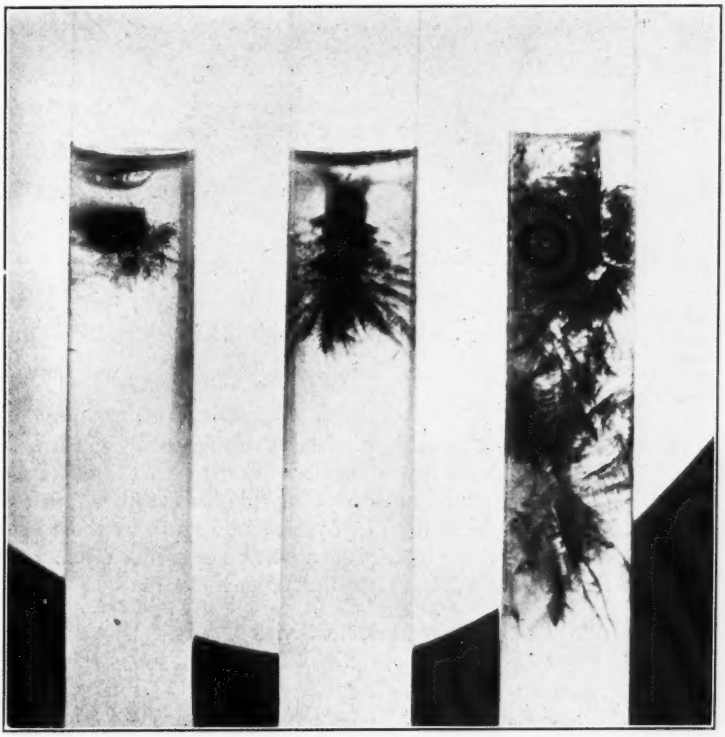


FIGURE 3

Reducing metal: zinc.
Concentration of lead acetate: 0.02 *N.*
Age: 21 days.
Tube on right contains no zinc nitrate, middle tube 5 cc., and one on left 10 cc. of saturated zinc nitrate solution.

zinc of the reducing and oxidizing agents. For example, if zinc nitrate be added to the gel-forming solutions when zinc is used as the reducing agent, the rate of growth of the lead crystals is considerably diminished. The addition of the zinc nitrate to the gel will make the potential of Zn/Zn^{++} more positive (*i. e.*, less negative) with increasing concentration of zinc salt. This will tend to make the potential of zinc approach that of lead, thereby diminishing the driving potential of the reaction (the algebraic difference between the lead potential and that of zinc). Figure 3 illustrates this effect very clearly. In fact, as will be seen in the solution containing the most zinc nitrate, the growth of the lead crystals is almost completely inhibited.

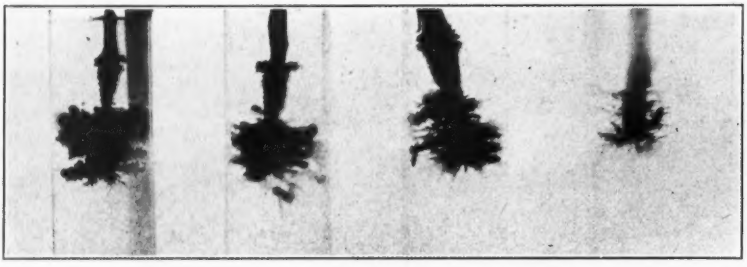


FIGURE 4

Reducing metal: Silver.
Concentration of lead acetate: Diminishes in tubes from left to right.
Age: 11 days.
The cyanide solution has diffused down into the lower solution and stopped the growth of the trees.

Again, in textbooks of general chemistry there is usually given a displacement or electromotive series with a statement to the effect that each given metal will displace those following it in the list from their compounds and will be displaced from its compounds in turn by those above it in the list. The following table gives a portion of such a displacement series, together with the normal potential[8] of each element.

Displacement Series

Element	*Normal Potential*
Sodium	−2.7
Calcium	−2.5
Magnesium	−1.6
Aluminum	−1.3
Manganese (Mn^{++})	−1
Zinc	−0.76
Chromium (Cr^{++})	−0.6
Iron (Fe^{++})	−0.43
Cadmium	−0.40
Cobalt	−0.29
Nickel	−0.2
Tin	−0.14
Lead	−0.12
Hydrogen	0
Copper	+0.3
Mercury (Hg^{+})	+0.79
Silver	+0.80

If this displacement series were correct then only those metals above lead would be able to displace it from solutions of lead salts. As a matter

[8] The potential at 25°C. when the concentration of metal ions in contact with the metal itself is 1 g. mole per 1000 g. of water.

of fact it is possible to so arrange conditions that some of the metals above lead will not displace it and some of those coming below it may be made to precipitate lead from its solutions. Thus, in Figure 4 are shown some lead crystals being deposited by silver. The experimental arrangement for this result was achieved by preparing the solutions containing the lead salt and acid, mixing it with the silicate solution and allowing them to gel. Before gelation had commenced a strip of silver was partially immersed in the solution and supported until the gel had set. There was then placed upon the top of the gel several inches of a second silicate solution containing no lead salt and the minimum of acid necessary to produce gelation; this was then allowed to gel. The silver strip was of sufficient length to protrude through the second gel layer. Upon the top of the second gel was placed a solution of potassium cyanide. The arrangement is indicated in Figure 5.

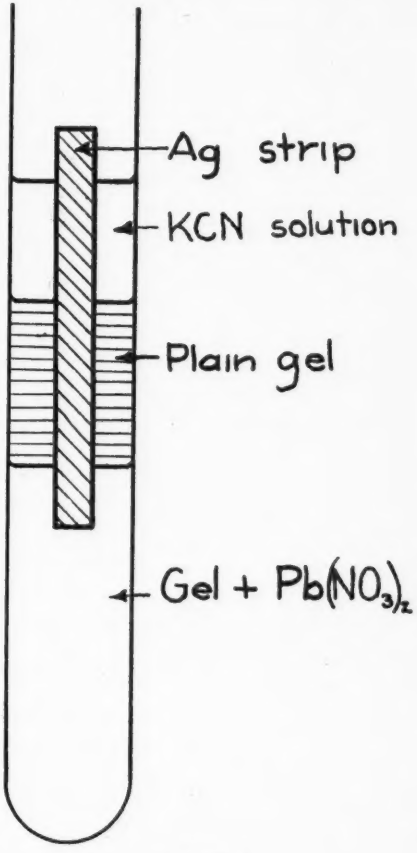


FIGURE 5

Under these conditions, the potential, Ag/Ag^+, is reduced to a smaller value than that of Pb/Pb^{++}, due to the very small concentration of silver ions in a cyanide solution; the lead thus being precipitated.

The plug of neutral gel is used to prevent immediate diffusion of the cyanide solution into the gel containing the lead salt, for if the cyanide were placed directly on the "lead" gel the concentration of lead ions would be enormously decreased, which would thus prevent their reduction.

In a similar manner lead, copper, brass, and hydrogen were used to produce lead trees (some of these are shown in Figure 6). In the case of

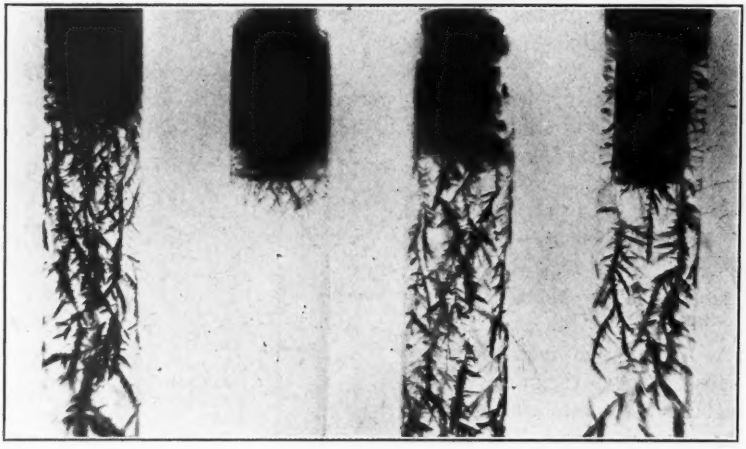


FIGURE 6

Reducing metal: silver, copper, lead, nickel (from left to right).
Concentration of lead acetate: 0.05 *N*.
Age: 11 days.
In the case of silver, copper, and nickel the top of the metal was bathed in a solution of sodium cyanide; in the case of lead, sodium hydroxide was used.

hydrogen, a strip of platinum was used and hydrogen bubbled around the upper platinized end which was placed in a solution of 1 *N* NaOH. It was noticed in the cases where silver and copper were employed as reducing agents that after some time the topmost crystals of lead became silver or copper plated. This is explained by the increasing concentration of the Ag^+ (or Cu^{++}) which would result as the cyanide ions diffuse down into the gel. Most probably the simple cyanide ions would diffuse faster than the complex metal cyanide ones, thus giving rise to an increasing concentration of the simple metal ions. With increasing concentration of Ag^+ (or Cu^{++}) the potential of Ag/Ag^+ would rapidly rise and soon exceed that of Pb/Pb^{++}, in which case Pb would be oxidized and Ag^+ reduced to the metal, that is, the reaction becomes reversed.

It should be noted that the device employed in Figure 5 is in reality a voltaic cell, *i. e.*, it is necessary to have a complete electrical circuit. In the case of hydrogen, for example, positive ions disappear at the lower end and appear at the upper end (H^+) of the platinum. For every gram atom of lead deposited a molecule of hydrogen is oxidized. A compensating change must also occur for the anions. Here the adjustment occurs by migration of anions upward through the neutral gel; for every equivalent of H^+ appearing at the upper end a corresponding equivalent of anion

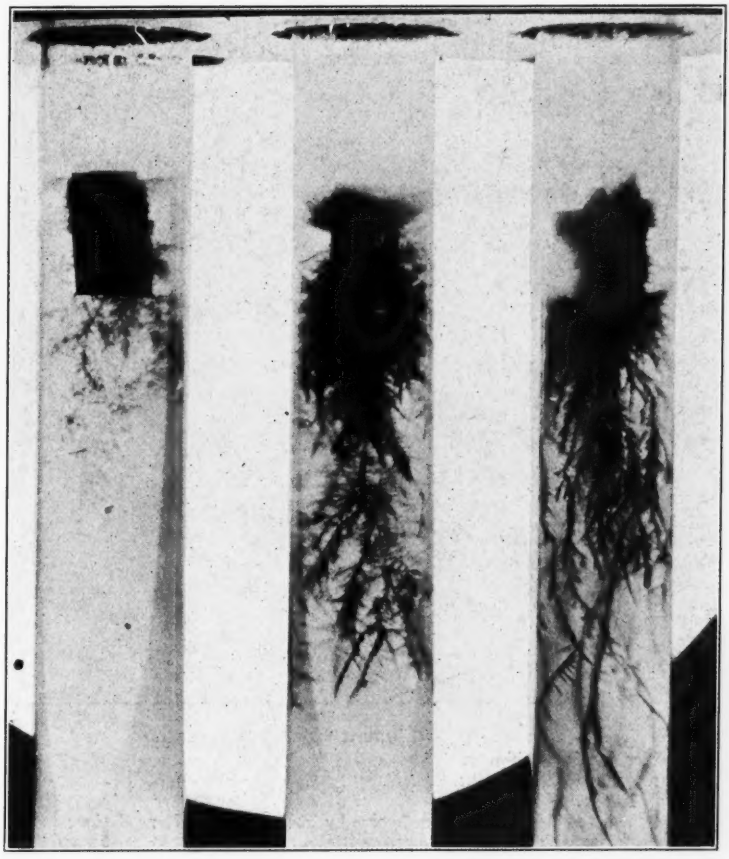


FIGURE 7

Reducing metal: zinc.
Concentration of lead acetate: 0.02 *N.*
Age: 21 days.
Tube on right is agar gel; other two are silica gels. Tube on left contains 5% of glycerin, thus increasing viscosity of intercellular liquid as compared to the middle tube which contains no glycerin.

must leave the lower solution and pass into the topmost one; the circuit is completed by the metals themselves. (Compare Figure 2.)

All of the reducing agents listed previously, with the exception of nickel, cobalt, and chromium, gave lead trees. By using the device illustrated in Figure 5 it was possible to obtain good crystal growth with nickel, but cobalt and chromium were not tried under these conditions. The failure

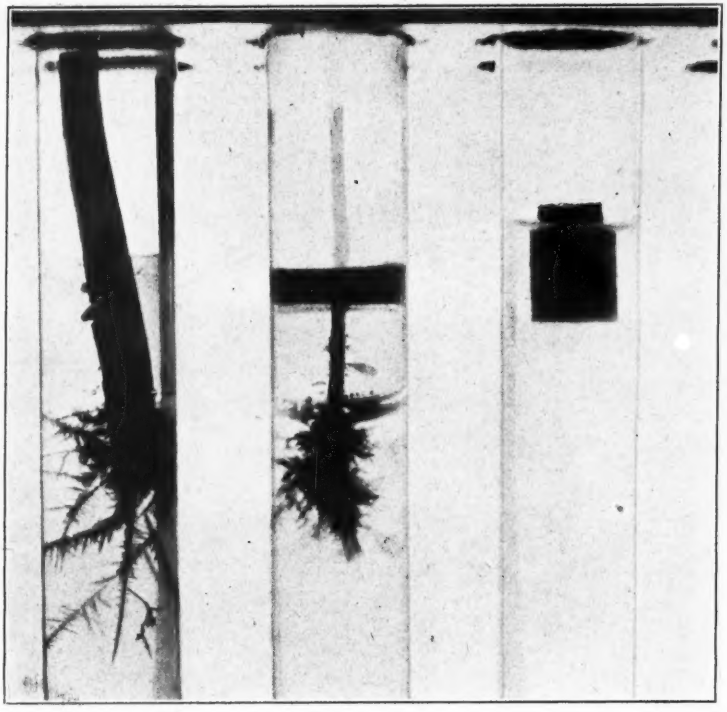


FIGURE 8

Reducing metal: aluminum.
Concentration of lead acetate: 0.02 *N.*
Age: 11 days.
To the tube on the left was added some hydrochloric acid after gelation; to the middle tube some sodium hydroxide; and to the tube on the right neither acid nor alkali were added.

to obtain lead deposits mentioned above we attributed to a possible overvoltage of lead on these metals, rather than to their well-known passivity, as in each instance there was abundant evidence that the metal had dissolved.

All other factors remaining the same, one would expect the greatest rate of growth with a reducing agent that comes near the top of the displacement series, due to the greater driving potential of the reaction. In the case of sodium amalgam, for instance, growth of lead crystals was apparent instantly, but hydrogen was likewise evolved. The evolution of the gas and the considerable alkalinity produced soon separated the amalgam from the gel and growth stopped.

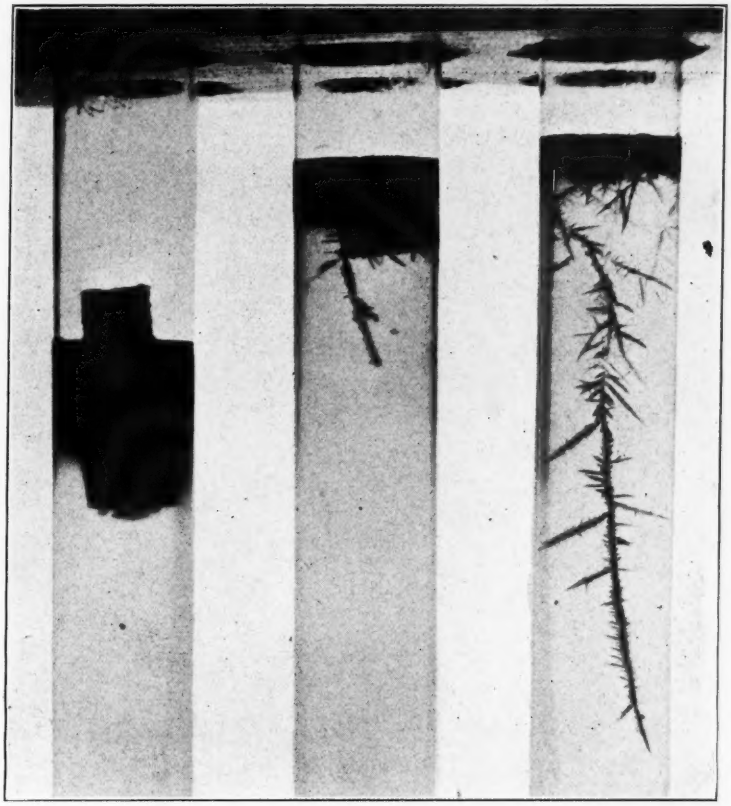


FIGURE 9

Reducing metal: iron.
Concentration of lead acetate: 0.02 *N.*
Age: 21 days.
Tubes contain varying amounts of acetic acid; left to right, concentration of acids were 3%, 2½%, 2%; the 2% gel being nearly neutral.

In general we were able to trace at least four factors which determined the rate of growth of the crystals: (1) The difference in the electrode potentials as above described. This would determine whether or not the reaction was a possible one. (2) The rate of diffusion of lead ions through the gel to the lead crystals already formed. As lead ions are reduced their concentration diminishes and consequently the potential Pb/Pb^{++} becomes more negative, *i. e.*, approaches that of the reducing agent. Consequently unless more lead ions diffuse in to take the place of those deposited, the rate of growth will be decreased. The rate of

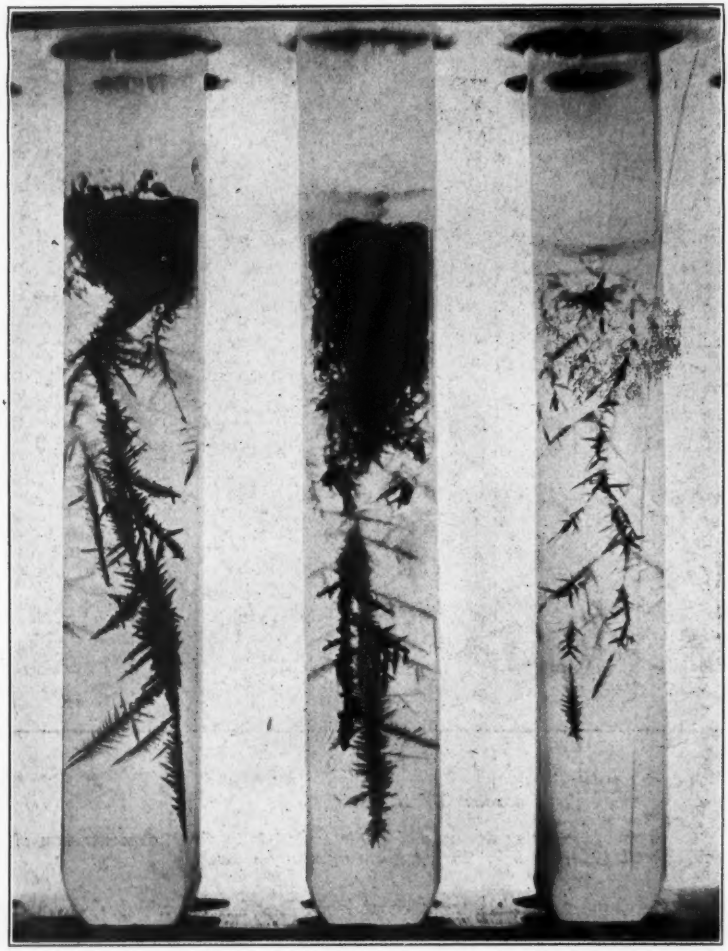


FIGURE 10

Reducing metals: (left to right) manganese, zinc, thallium.
Concentration of lead acetate: 0.1 *N*.
Age: 21 days.

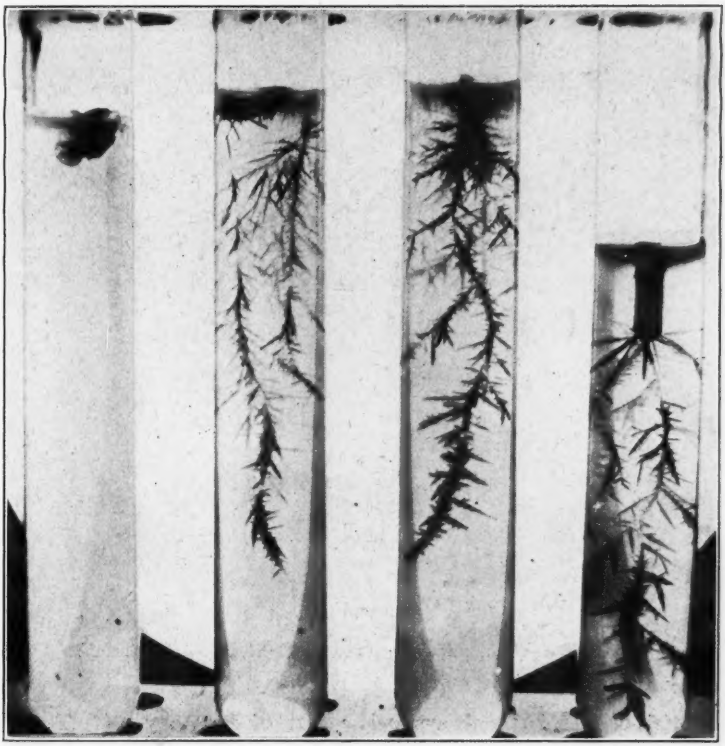


FIGURE 11

Reducing metal: tin.
Concentration of lead acetate: 0.02 *N.*
Age: 21 days.
Acetic acid concentration increases from left to right, being 2%, 2½%, 3%, and 3½%; the 2% gel being neutral.

diffusion of lead ion will be determined in these cases by the viscosity of the intercellular liquid present in the gel. By increasing this viscosity the rate of growth can be considerably retarded (see Figure 7). (3) The rate of diffusion of the element oxidized away from the upper end of the "cell." This rate of diffusion will be tied up with the solubility of the salt produced; or to put it another way, it will depend upon the ease of solution of the reducing agent. For example, aluminum by itself does not precipitate lead, but when the upper end of a strip of aluminum is wet by either acid or alkali, lead trees begin to grow immediately (see Figure 8). Under these conditions the aluminum dissolves more readily and the resulting aluminum ions diffuse away rapidly, thus keeping the

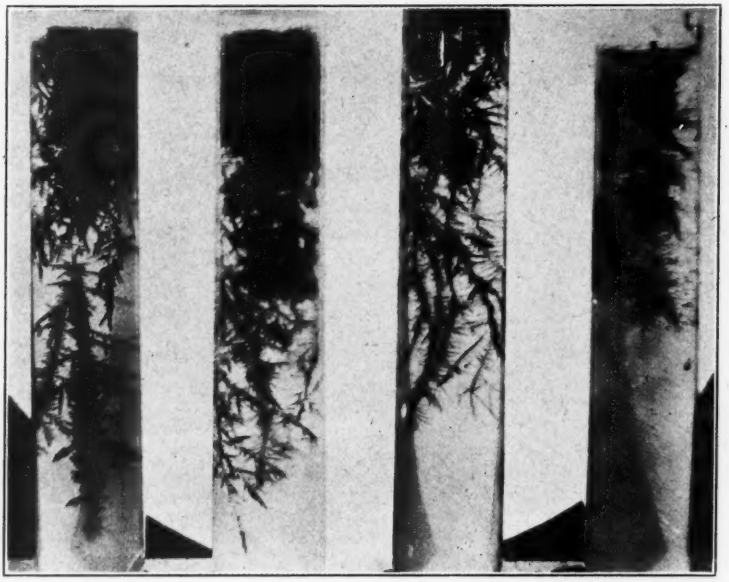


FIGURE 12

Reducing metal: zinc.
Concentration of lead acetate: (left to right) 0.1, 0.05, 0.02, 0.01 *N.*
Age: 21 days.

potential of Al/Al^{+++} always below that of Pb/Pb^{++}. (4) The hydrogen-ion concentration of the gel. This factor is intimately connected with a number of others. It plays an important part in the time required for the gel to set and thus affects the structure of the gel which in turn will affect the rates of diffusion of all substances concerned; it may determine the solubility of the products of oxidation; it may be present in such concentration that it is preferentially discharged in place of lead ion, thus giving rise to an evolution of gas, etc. Increasing the hydrogen-ion concentration (or acidity) causes some reducing agents to act more rapidly and others more slowly, dependent upon the net resultant of the above factors. Thus with iron as the reducing agent (Figure 9) the greatest growth was obtained in the least acid solution; with tin (Figure 11) greatest growth was obtained in the most acid solution tried; in the case of cadmium the variation of acidity had no appreciable effect.

Another striking factor which is quite evident from an examination of the trees or of their accompanying photographs is that the form of the tree (not the individual crystals, of course) is characteristic of the reducing agent. Thus tin gives a feather-edged tree (Figure 1); zinc (Figure

FIGURE 13

Reducing metal: zinc.
Concentration of lead nitrate: (left to right) 0.1, 0.05, 0.02 *N.*
Age: 11 days.
Notice that varying the concentration of lead salt does not have the effect that it did in the case of lead acetate (Figure 12).

10) gives a very dense deposit at first, the lead crystals then appearing as long, flat, angular blades; cadmium (Figure 1) is characterized by producing lead crystals radiating uniformly at first from the metal; iron (Figure 1) by long, flat blades growing straight down through the gel; thallium (Figure 10) by light blades of lead always bent spirally, etc.

Still another factor of interest can be seen illustrated in Figure 7, the lead tree being formed in an agar gel rather than silica. We have not followed up this point extensively but it would be of interest to try other gels. In general we would expect that the greater the protective ability of the colloidal media the smaller the crystals would be. In Figure 7

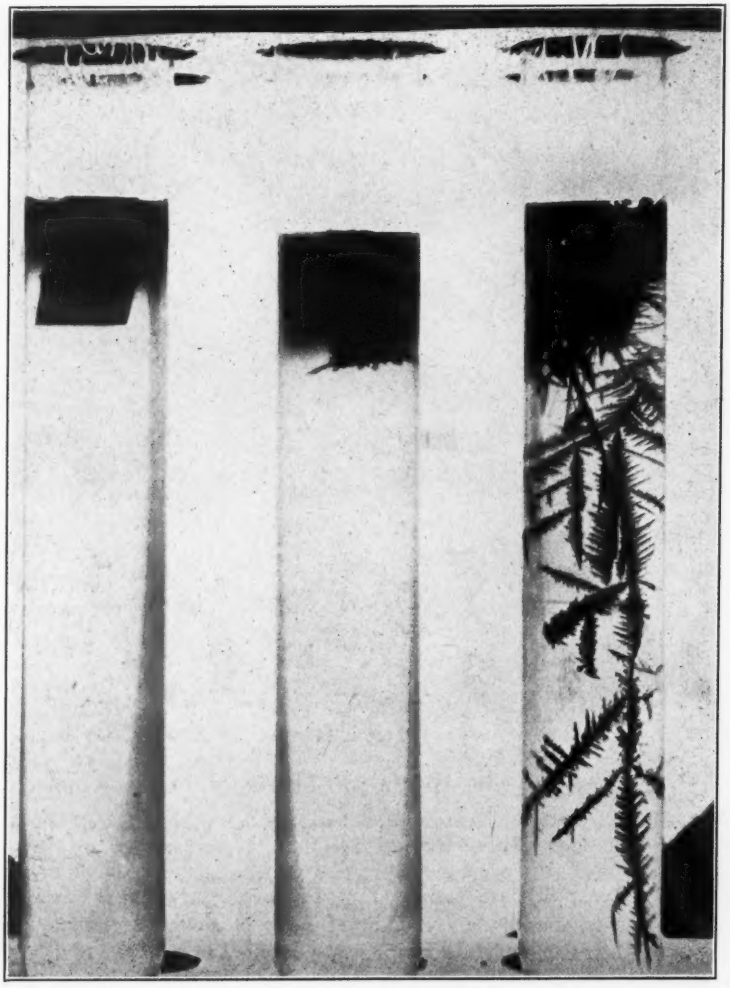


FIGURE 14

Reducing metal: iron.
Concentration of lead nitrate: (left to right) 0.02, 0.05, 0.1 *N*.
Age: 11 days. (Compare with Figure 9.)

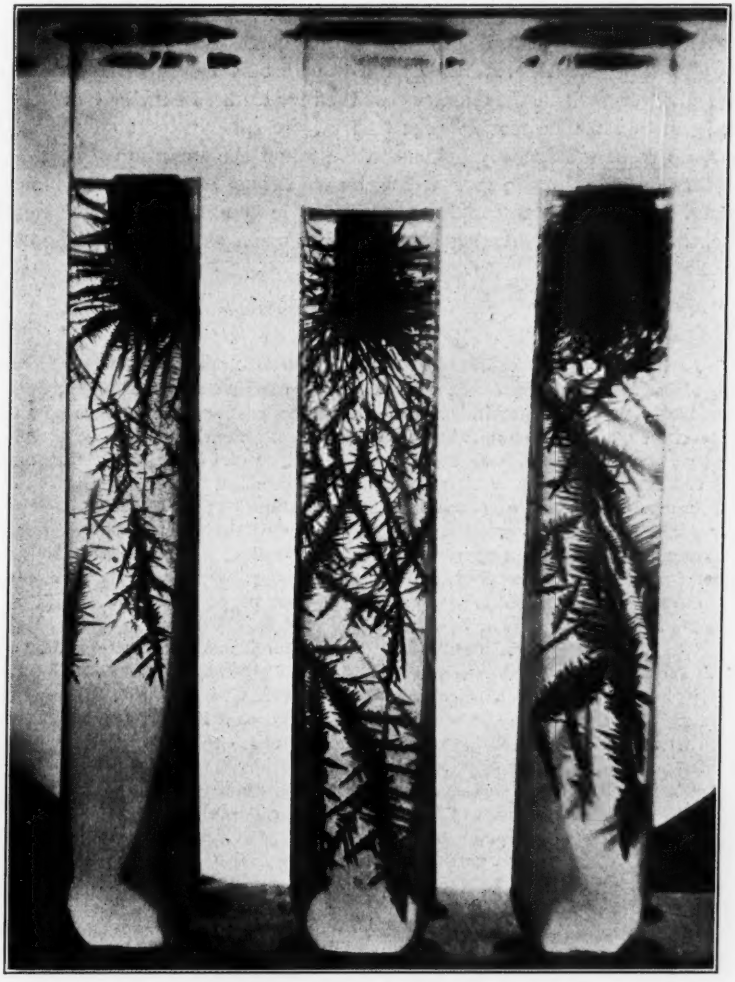


FIGURE 15

Reducing metal: cadmium. *Concentration of lead acetate:* (left to right) 0.02, 0.05, 0.1 *N*. *Age:* 21 days.

the lead tree formed in agar is far less coarse than that formed in silica under otherwise similar conditions. Agar, it will be recalled, is a much better protective colloid in the *sol* form than is sodium silicate solution.

Other metals may also be grown as trees in gels. We have not examined the list of possibilities extensively but have grown a number of cadmium and silver crystals in the manner described for lead. In the case of silver, the growth must be made in the dark as the silver compound ($AgNO_3$) appears to be particularly light sensitive under the conditions employed, rapidly decomposing to give a dark brown deposit, presumably colloidal silver. Very likely any metal under suitable conditions could be made to produce these interesting growths in the presence of the supporting media of the gels.

Depleted Wells May Be Used for Storage of Manufactured Gas. A new visualization of America's gas industry of the future, when surplus gas can be manufactured and stored in underground natural gas wells and partly depleted sands in amounts sufficient to meet the country's maximum house-heating demands, thereby solving one of the industry's greatest problems, was described at the Pacific Coast Conference of the American Gas Association by S. W. Meals of Pittsburgh, president of the Carnegie Natural Gas Company and chairman of the Association's Natural Gas Department.

Mr. Meals pleaded for closer coöperation between the gas and oil operators in properly protecting producing sands with a view to using partly depleted sands for storage purposes. He also advised that large-volume gas wells, when the sand is free from water, should be protected and not plugged when the gas is depleted. Such wells should be retained for storage, he declared.

The idea of storing large amounts of manufactured gas in discarded natural gas wells is original with Mr. Meals, and is based on the experience of the natural gas industry in storing large volumes of gas in the summer time and using it during the winter. Such practice, he said, is now followed in sections of Kentucky, West Virginia, Pennsylvania, New York, Oklahoma, and Texas, although this is not generally known by the public.

"One company has stored more than eight billion cubic feet of gas in some eighty wells covering an area of about 27 square miles," Mr. Meals explained. "At Buffalo, New York, use of underground storage has been of great value in meeting the severe winter load. The gas was purchased in the Pennsylvania field during the summer months and stored in 23 wells located within an area of eight hundred acres. The average depth is 1900 feet. The first well was drilled in 1888. The greatest amount stored at any one time was about three hundred million cubic feet, but nearly three billion cubic feet have been stored and used as needed since June, 1916."

Mr. Meals said Butler, Pa., has an ideal operating condition, due largely to one well in which gas is permitted to feed when the line pressure is built up. Butler, he declared, has never known a shortage of gas.

Speaking of his own company, Mr. Meals stated that a well had been used for storage purposes for twenty years. The well is located near Pittsburgh and is connected with a 24-inch pipe line to the steel mills. The practice of storing natural gas in this way, he said, constitutes an operating efficiency rather than a program of conservation.—*Gas Service Journal*

THE BANANA—A CHALLENGE TO CHEMICAL INVESTIGATION

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One hundred and twenty-six years have elapsed since what was probably the first importation of bananas into this country. At that time thirty bunches were brought from Cuba to New York. In 1929 the total importations were sixty-five million bunches. In past years the biochemist, physiological chemist, and physical chemist have made concerted efforts for a thorough study of this fruit.

Tannins

It has been known for some time that an unripe banana is characterized by its high starch content, its astringency, and lack of sweetness. The ripe fruit, on the other hand, has little starch and is not noticeably astringent. It is claimed that the astringency is due to tannins in the unripe fruit which are in the soluble form. As the fruit ripens the tannins are said to become insoluble or "fixed," as it were, in sort of a "vegetable leather," and hence cannot be tasted in ripe fruit. Analyses of the tannin content of the banana may be found in the literature, but just what is meant by "tannins" is not always clear. Yoshimura[1] followed the tannin change during the ripening process and concluded the tannin remained unchanged and was independent of the process of maturation.

The occasional gastrointestinal disturbances following the ingestion of unripe fruit have been linked with the tannin present in the fruit. The evidence is unconvincing and a more thorough investigation of the tannin change in the banana with special emphasis upon the kinds of tannins present at different stages of ripeness would be a valuable contribution to the chemistry of this fruit.

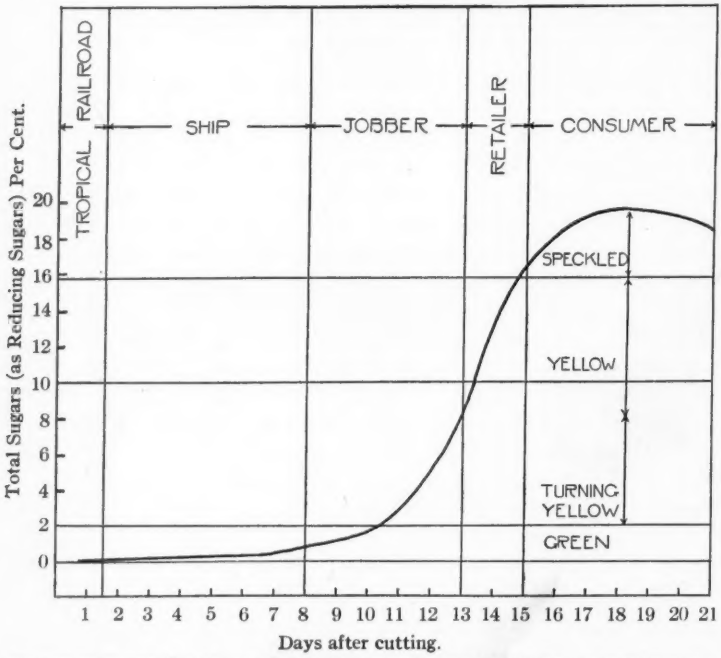
Pectin

The hardness of the green banana is due to the fact that the cells are cemented together by an insoluble substance known as protopectin. As the fruit ripens the protopectin is changed by enzymes into pectin and finally into various semi-acid and acid bodies. Pectin will swell in water to form a jelly, provided the concentration of sugar is correct and the pH is at the optimum point. Neither protopectin nor pectic acid will form a jelly. As the protopectin is changed into pectin the fruit becomes soft in texture, because the cell walls are no longer cemented together by protopectin. During ripening the total pectin (protopectin plus pectin) remains practically constant, but the pectin increases until the fruit becomes overripe, at which time a good part of the pectin has been changed into acid and semi-acid bodies. This is the explanation usually given to account for the softening of the fruit during maturation. In reality it is

[1] Yoshimura, K., *Z. Nahr. Genussm.*, **21**, 406 (1911).

not as simple as this, for there are occasional increases in the protopectin content that cannot be readily explained.

The total pectin content of the banana is not great (about one per cent of the fresh pulp), but what relation this substance bears to the digestibility of the fruit is unknown at the present time. Is banana pectin attacked by the gastric juice? Is it affected by the intestinal enzymes? Or does it merely act as roughage in the same manner as cellulose, to be



CHANGES IN THE COLOR AND SUGAR CONTENT DURING THE LIFE OF THE BANANA

This diagram shows the changes in color of the peel and the sugar content of the pulp during the life of the banana. The curve for the sugar was derived from over five thousand analyses of the pulp of bananas.

subjected to bacterial decomposition in the large intestine? These are questions for the biochemist and physiological chemist to answer.

Starch and Sugars

During ripening the starch in the bananas is converted into sugar (dextrose, levulose, maltose, and sucrose) by means of enzymes. Bailey,[2] in his biochemical studies of the banana carried out eighteen years ago, was

[2] Bailey, *J. Am. Chem. Soc.*, **34**, 1706 (1912); *J. Biol. Chem.*, **11**, 42 (1912).

unable to detect maltose in the fruit, but recent work in this laboratory (unpublished data) established its presence. The quantitative determination of the different sugars in the banana, followed along as the fruit ripens under controlled conditions, awaits the chemist. If levulose is the predominating sugar in the ripe fruit this may explain, in part, why diabetics are better able to tolerate the carbohydrate of the banana than carbohydrates of other fruits and vegetables. Furthermore, the laxative effect of ripe bananas may be due to levulose, for Folin and Berglund[3] have shown administration of levulose is accompanied by diarrhea.

The treatment of citrus fruits with ethylene and other gases of the same series has been carried out with success by Denny, Harvey, and others. The results with bananas have not always been so striking. If the fruit is going to ripen it will do so about as quickly with ethylene as it will without. However, in the case of "dormant fruit" (the meaning of which we do not know with any degree of certainty) ethylene hastens ripening. Just why this is so we do not know. Does this gas stimulate the enzymes? Perhaps, but Rea and Millinix[4] have shown that corn and wheat starch can be converted to reducing sugars without the presence of an enzyme, the conversion taking place by merely bubbling ethylene into the starch suspension. More recently Nord and Franke[5] have shown that in the case of tobacco leaves ethylene increases the permeability of the cells and acts as a protector.

PHOTOMICROGRAPH OF STARCH GRAINS IN THE PULP OF AN UNRIPE BANANA

As the fruit ripens these starch grains are seen to disappear almost completely.

A ripe banana contains as high as 18 per cent reducing sugars (see diagram on page 1538) which may be fermented under suitable conditions to alcohol. The alcohol obtained may, in turn, be oxidized to form acetic

[3] Folin and Berglund, *J. Biol. Chem.*, **51**, 213 (1922).

[4] Rea and Millinix, *J. Am. Chem. Soc.*, **49**, 2116 (1927).

[5] Nord and Franke, *J. Biol. Chem.*, **79**, 27 (1928).

acid or vinegar. Banana vinegar is light yellow in color and possesses an agreeable aroma and taste comparing favorably with cider vinegar.[6]

Latex

When the peel of a green banana is punctured, a sticky, milky fluid oozes from the wound. Under the microscope this liquid is seen to consist of numerous spherical bodies ranging in diameter from 3.5 to 31.5 μ. These particles can be made to coalesce, under suitable conditions, forming an exceedingly tacky gum. Esch[7] claimed this substance was India rubber and later Griebel[8] also spoke of it as rubber. More recent investigations have shown the material is not rubber, but a body very closely resembling chicle,[9] containing 44.4% acetone-soluble resins, 34.4% ether extract (hydrocarbons), 13.6% albans, 15.4% fluavil, 2.4% protein, and 0.4% ash. Attempts to vulcanize the gum were not successful. Because of its low melting point, difficulty of extraction and instability, it could not be readily used as a substitute for chicle.

LONGITUDINAL SECTION OF A BANANA STALK

At *a* the fibro vascular bundles are shown, important in the preparation of paper; *b* indicates the parenchyma, or pith.

The peel of the banana also contains pectin ranging in amounts slightly more than in the pulp. This pectin can be extracted by dilute acids (preferably organic acids) and the extract either concentrated or dried to obtain a commercial pectin.[10]

[6] von Loesecke, *Ind. Eng. Chem.*, **21**, 175 (1929).
[7] Esch, *Gummi Markt.*, **4**, 83 (1915).
[8] Griebel, *Z. Nahr. Genussm.*, **48**, 221 (1923).
[9] von Loesecke, *Rubber Age*, **22**, 129 (1927).
[10] von Loesecke, *Fruit Products J. & Am. Vinegar Ind.*, **8**, 14 (1929).

Color Changes in the Peel

As the banana ripens the peel of the fruit changes in color from green to yellow. (See diagram on page 1538.) The green color of the peel is due to chlorophyll ($a + b$) which ranges from 102.9 to 51.7 milligrams per kilogram of fresh peel in the unripe fruit at discharge from the boat at an American port, and decreases as the fruit ripens.[11] The yellow color of the peel of the ripe fruit is due to xanthophylls and carotin and these pigments have been found to remain approximately constant throughout ripening. In other words, a green banana contains just as much yellow pigment as a ripe banana, the color being masked by the chlorophylls in the case of the unripe fruit. When the chlorophylls break down, the yellow color of the xanthophylls and carotin becomes apparent.

Esters

A green banana has a cucumber-like odor, but as the fruit ripens the characteristic banana aroma develops. This is due to the formation of esters, but the mechanism of their formation is still obscure. The odorous constituents of the ripe fruit are present in very small quantities, amounting to about 0.0033 per cent of the weight of the pulp (unpublished data). The chief ester is amyl acetate (the so-called "banana oil" of commerce used in certain paints and lacquers) but valerates of ethyl and methyl alcohol are also known to be present.

The odorous constituents of the banana are extremely unstable and are destroyed even when the greatest of care is taken to recover them unchanged. So far as the writer is aware no one has ever succeeded in commercially extracting the esters of the banana so that the extract would be comparable with the odor of the fresh fruit. Such an extract, if successfully prepared, would be of great commercial importance as a flavoring material for ice cream, desserts, and tonics. The buying public is being educated more and more to demand natural products and to scorn all that is artificial.

Protein and Fat

The banana contains but little protein (from 0.8 to 1.3%, depending upon the variety of the fruit), but there are no data available in the literature concerning the extraction of the protein *per se*. The biochemist and physiological chemist are now tackling this problem and the investigation will not only throw more light on the nutritive value of the fruit itself, but will also add to our knowledge of the chemistry of proteins. Nor has the fat of the banana been investigated. It would be interesting, for instance, to learn whether bananas contain ergosterol, the provitamin D. If the fruit does contain this sterol, banana flour could be irradiated and become an important source of vitamin D.

[11] von Loesecke, *J. Am. Chem. Soc.*, **51**, 2434 (1929).

Nutritive Value

The nutritive value of the banana has been the subject of many researches and these researches have definitely shown the fruit to be permissible to people of all ages. Gastrointestinal disturbances following the ingestion of the fruit are due to either eating unripe fruit or to some allergy certain individuals may have for bananas. Many cannot eat eggs or strawberries or tomatoes because of some allergy, yet these products have never been condemned in the same manner as bananas.

Researches of Eddy and others have shown the banana to be an excellent source of vitamins A and C; a good source of vitamin B (*i. e.*, B, the factor necessary to prevent beriberi in man, and G, the factor necessary to prevent pellagra), deficient in D and not lacking in vitamin E. Its potency in vitamin C, the availability and the relative cheapness of the fruit make it a competitor with tomato and orange juice for infant feeding on vitamin basis alone.

Banana Flour

Numerous attempts have been made, and are still being made, to prepare a suitable banana flour or powder. It is comparatively simple to prepare a flour, but it is quite another matter to develop a wide market for it. Flour is prepared from either green or ripe fruit, the latter being the more difficult to obtain because of the hygroscopic nature of the sugars in the ripe fruit. Green banana flour has a characteristic taste varying between "shorts" and violets. Its use in baking is limited because it contains no gluten and also because it darkens when heated, imparting an unsightly appearance to the baked goods. Ripe flour has a sweet taste and may occasionally suggest the aroma of the fruit from which it was obtained. The most promising use for this product seems to be in the field of therapeutics where its properties should be of value in certain dietaries, and in instances where fresh fruit is not readily available. There are undoubtedly other uses for the flour as yet unconceived. Opportunity awaits the chemist who can prepare banana flour cheaply and find an unlimited market for his product after he has prepared it.

Analyses of Banana Flour

	Green Banana Flour	*Ripe Banana Flour*
Water	12.08%	2.59%
Protein	4.85	4.09
Fats	0.61	1.91
Ash	3.09	3.05
Starch	69.35	29.87
Sucrose	2.28	33.25
Reducing sugars	0.95	15.62
Crude fiber	0.73	...

Banana Stalks

The stalk of the fruit, to which the hands of bananas are attached, contains about 93 per cent water and 1 per cent ash. The ash is very rich in potash, varying from 53 to 63 per cent potassium oxide, depending upon the variety of fruit. During the World War and the period immediately following the conflict, when potash shipments from Germany were curtailed, numerous attempts were made to recover this potash from the stalks.[12] At the present market price of potash it would require about one ton of the stalks to obtain $3.00 worth of potash. Banana stalks have also been suggested as the basis for a dye[13] and as the raw material for the preparation of paper,[14,15] but the difficulty of collecting the material, in this country at least, would seem to preclude any great use for it.

[12] Ellis, *J. Soc. Chem Ind.*, **35,** 456 (1916). Billings and Christie, *Ind. Eng. Chem.*, **9,** 153 (1917).

[13] U. S. Pat. 1,243,042, Oct. 16, 1917.

[14] Reifegerste, *Wochbld. Papierfabr.*, Sondernummer, **57,** 75 (1926).

[15] Brit. Pat. 293,219, Aug. 15, 1927.

Boiling Milk in Aluminum Does Not Destroy Vitamin C. Aluminum cooking utensils have no selective destructive action on the antiscorbutic vitamin of milk, according to the results of experiments carried out at Mellon Institute of Industrial Research, Pittsburgh, Pa. Milk, man's most nearly perfect food, has particular importance in the dietary of the infant and child. There has been a growing tendency to boil milk whenever it is to be used in supplemental feedings, or whenever a supply is of doubtful origin. In thus safeguarding the health of children against microörganisms and in providing for better assimilation of the proteins, mothers may be assured that when they use aluminum utensils for the preparation of milk they are not depriving this invaluable foodstuff of its antiscorbutic properties.

In the Mellon Institute experiments milk was boiled lightly for five minutes in aluminum or glass containers. Some destruction of vitamin C occurred in each case as a result of the boiling, but the metallic utensils exerted no greater action than did those of glass. Another interesting observation is that winter milk from ensilage-fed cows is practically as potent in vitamin C as the best summer milk from cows on pasturage.

Full details of the experiments will be supplied by Mellon Institute on request.

Glass Resists 15-Ton Pressure. A bit of glass about a sixteenth of a square inch in area, bearing a load of approximately fifteen tons, is the simple new weapon of science developed by Prof. Thomas C. Poulter of Iowa Wesleyan University.

It served as a tiny window looking into a pressure-chamber, where experiments are performed under the tremendous pressure of thirty thousand atmospheres. The little glass window is ground perfectly flat and set against a disk of high-speed steel, also ground perfectly flat. There is no gasket; the pressure attends to the sealing of glass against metal.—*Science Service*

THE TEACHING OF CHEMISTRY IN THE SCHOOLS AND INSTITUTES OF FRANCE*

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Chemistry in Pre-University Instruction

In Latin countries the traditional emphasis upon literary instruction has the advantage of developing the mind and promoting clear and methodical expression of thought. In regard to instruction in the sciences (Latin sciences, language sciences, and elementary mathematics) chemistry is usually given a secondary place and is generally taught by a professor who is more of a physicist than a chemist.

The first elements of the subject are usually given one hour weekly at about the seventh year to students between twelve and thirteen years of age. The instruction is very superficial and embraces the principles of chemical nomenclature, the properties of certain common elements and compounds, such as Cl_2, HCl, H_2SO_4, the metals and carbon, followed by simple notions of organic chemistry. The practical work is very elementary and consists principally of such experiments, demonstrated by the professor and his assistants, as will serve to stimulate the taste of the students for experimental science. This cycle of studies prepares for the first part of the baccalaureate, which consists only of an oral examination upon the ground covered.

In the classes of philosophy and even more so in those of elementary mathematics, the teaching of chemistry is a little more complete and prepares for the second part of the baccalaureate. It sometimes includes in addition to the required oral examination a simple problem or written questions upon chemistry.

Those who continue their studies with the view of preparing for the advanced schools, of which the programs will be reviewed later (classes of special mathematics, of the Central School, and of the Agronomic Institute), find the chemical programs more comprehensive, especially in regard to chemical laws and the study of the metalloids. These programs, however, are arranged principally in reference to the questions which might be asked in the examinations for entrance to the advanced schools.

The deficiencies which exist in the pre-university teaching of chemistry are common to most countries. There is little doubt that in France greater appreciation of the rôle of chemistry and of the experimental sciences in general is resulting in the improvement of the programs of instruction and the attraction to chemistry of students of the highest qualifications.

* Translated by Atherton Seidell, Hygienic Laboratory, U. S. Public Health Service, Washington, D. C.

[1] Ingénieur chimiste and member of the Bureau of the Société de chimie industrielle de France.

Chemistry in the Science Faculties of the Universities

The courses of chemical instruction in the science faculties prepare the students for the several certificates (*licence ès sciences*), of which the principal ones are general chemistry, applied chemistry, physical chemistry, biological chemistry, etc., to which should be added the certificate of physical science, physics, chemistry, and natural science (P.C.N.). These certificates can be obtained only by students who have successfully passed the baccalaureates. The programs of the courses corresponding to the various certificates are given the greatest attention by the professors and lecturers, and consequently chemical courses in the faculties of science are excellent. A detailed exposition of these programs will be given later in connection with the description of the teaching of chemistry in the institutes and schools of chemistry of the faculties of science.

In regard to theoretical instruction, the courses are essentially the same in the different branches of chemistry. One of the most useful of them is that of general chemistry for which the instruction may have a very favorable influence upon subsequent studies, since it provides a thorough foundation in chemical laws and the broad relations existing among chemical compounds. In addition to instruction in theory, practical work and manipulations familiarize the students with the laboratory, insure a better comprehension of the facts described in the lectures and emphasize their practical application.

The three certificates of licence (sciences) give the holder the right to the title *licencié-ès-sciences*, which is a state diploma. In this connection it should be remarked that if the student is a candidate for the degree of *Doctor d'Etat ès-sciences physique*, which makes him eligible to a professorship, he must have obtained as one of his certificates that of general physics.

For the *doctorat d'État* no additional courses are required, but the candidate is given daily practical instruction in the laboratory of the professor under whom he prepares his thesis. The thesis must be an original research upon a subject recommended by the professor, and upon completion must be defended before a special jury designated by the faculty. In addition to this original work, the faculty prescribes a secondary question which is simply a subject for review. This doctorate really marks the completion of the university chemical instruction leading to a professorship. It prepares the student for original scientific research which is the foundation of all useful discoveries. It develops his reasoning as well as his appreciation of method and deduction and is the initial stage of a future master.

In addition to this *doctorat d'État* there exists a *doctorat d'Université*, for which the *licence ès-sciences* is not obligatory and which consists in the presentation of an original thesis upon the same conditions as those pre-

scribed for the *doctorat d'État*. The *doctorat d'Université* does not, however, confer eligibility to a French professorship.

Chemistry in the Institutes and Schools of Chemistry

The transformations which the chemical industries are undergoing, the improvements and the incessant changes which must be introduced in order to meet ever-increasing world competition, and the necessity for reducing the cost of production, are the factors which determine progress. They cannot be resolved economically except by industrialists aided by collaborators possessing serious scientific and economic knowledge in which chemistry, physics, mechanics, and also personal and moral qualities necessarily play a considerable rôle.

In order to furnish to industry these collaborators and chiefs which it demands, there has been created in most of the faculties of science of the universities special institutes and schools of chemistry. Although they form a part of the faculties of science they, nevertheless, usually have a fairly autonomous existence. They may be subventioned by the state, the cities, the departments, the communes, the industrial societies, the chambers of commerce, industrialists or such individuals as are interested in the progress of science and its applications. This financial independence confers a certain freedom which often manifests itself by programs adapted specially to the industrial needs of the region. The students are chosen by competition, irrespective of the university degrees already obtained, or in certain cases from among the *bacheliers ès-sciences*. The age of entrance is in general 18 years. The cycle of studies extends over three years, and upon its successful completion a diploma of chemical engineer is awarded.

The particular aim of the instruction is to develop in the student the notion of discipline, responsibility, and the spirit of the scientific method. The courses, lectures, and practical work are judiciously coördinated with these ends in view. The studies are pursued to a degree that will permit the student on leaving the school to become the real collaborator of the industrialist. The training is such that he will be proficient in reading and understanding original researches and be able to derive from them all possible applications. The aim is to make the future engineer a competent collaborator of physicists, mechanicians, architects, and all with whom he must work.

The theoretical courses in chemistry given herewith are either common to those of the *licences ès-sciences* or individual according to the Institute.

Resumé of the Program of the Theoretical Courses

Mineral Chemistry.—Study of all the metalloids and their compounds. Study of the properties and the preparations of the alkali and alkaline earth metals. The magnesian metals. Series of iron and chromium. Rare earths. Precious metals.

Copper. Silver. Mercury. Gold and Platinum. Electro-metallurgy of the metals, etc.

Organic Chemistry.—(*a*) *Acyclic series:* Generalities—hydrocarbons, alcohols, aldehydes, ketones, acids, amines, amides, nitriles, complex groups, sugars, uric acid group, etc. (*b*) *Cyclic Series:* Generalities—benzene group with the principal groups which combine with benzene. Cyclicterpenes and different compounds employed in perfumery.

General Chemistry.—Physical and electrochemical units—thermochemistry, barometry, liquefaction of gases, thermodynamical principles, work of gases, law of Joule, calorimetry principles of thermochemistry, formula of Clapeyron, laws of chemical equilibrium, chemical affinity, etc.

General Laws of Chemistry.—Vapor density, dissociation, phase rule, alloys, cryoscopy, tonometry, ebullioscopy, ionization, rotatory power, etc.

Osmotic Pressure.—General laws applicable to gases and solutions. Law of equilibrium, variation of equilibrium with temperature and pressure, equilibrium in solutions, rapidity of reactions of different orders. Catalysis, etc.

Electrochemistry.—Law of Faraday, specific and molecular conductibility. Electromotive forces, electrolysis, cells and batteries, origin of electrical energy, large electro-chemical industries. Relation between physics and rational mechanics.

In the case of the individual courses they are in general superior to those of the *licence*, principally in regard to application, for they give a general view of present chemical industry and of its tendencies. These courses are those of general chemistry; mineral chemistry (metals, metalloids); analytical chemistry (qualitative, quantitative, microscopical detection of traces, spectroscopy, industrial analysis, mineral and organic); physical chemistry; theoretical and practical electrochemistry; in addition to a very large program of industrial chemistry. These form the basis of the theoretical instruction and extend over two years. Courses in higher mathematics (differential and integral calculus, analytical geometry, mechanics), technology, physics (general, acoustics, optics, heat, electricity), and of industrial drawing are also included in the regular program of the first two years of the institute. In addition to this theoretical instruction in these first two years a very important place is reserved for practical work in analytical chemistry, organic chemistry, physical and electrochemistry, as well as the testing of machines (thermic, electric, etc.) and periods of work in the various shops (glass, wood, metal). The mean length of time consecrated to this practical work may be placed at 900 to 1000 hours per scholastic year.

Frequent quizzes and semester examinations are given as well as examinations at the end of each year. The usual passing mark is twelve in twenty, thus requiring sustained work on the part of the students and insuring the retention only of those best qualified.

Beginning with the second year there are special courses in applied chemistry, mineralogy, solid, liquid, and gaseous fuels, metallurgy, metallography, etc. Some of the institutes and schools give at the end of these two years and after examination a certificate of chemist. In the third year,

in addition to intensive instruction in purely chemical branches, specialized courses are offered in those subjects involving the application of engineering. They include the heavy chemical industry, its material and industrial material in general, the refractory products, the coloring matters and dyes, the agricultural industries, the perfumery industry, etc.

It is also deemed indispensable to teach to the students the great principles of political and industrial economy, and to show them that an industry cannot develop unless it can find sufficient outlets for its products. But these outlets depend essentially upon the extent of world consumption and production, and also upon the relation between the cost of the merchandise as it leaves the factory and its possible price of sale on the market. These last elements are a function of the cost of production and in a certain measure the extent of the import taxes and the rights attached to industrial property, factors which in themselves constitute new instruction. Such is the object of the courses in industrial economy: economic administration, financial and technical organization, law, industrial and employees' legislation, accounting, industrial hygiene, etc. This instruction has a high economic and moral object. It serves to develop an appreciation of the rôle played by the engineer, the chemist, the director, and in general of all those who participate to any degree whatever in production.

In the third year the practical studies are supplemented by industrial tests related to the heavy chemical industry and to technology. Factories are visited and often during the second semester a research problem in the field chosen by the student is suggested by the professor. In general the problem includes a project of installing a factory, or part of a factory, related to the industry studied, with designs and plans, estimates of cost of production, etc.

During the three years of studies written, practical and oral examinations are given and the required passing mark is usually twelve to fifteen out of a possible twenty. Upon the successful completion of the courses a diploma of chemical engineer is awarded to the student by the university or by the Under-Secretary of State for Technical Instruction. Such instruction, as above outlined, always kept abreast of the scientific and industrial advances, has provided France with a corps of chemical engineers of high technical skill. This is attested by the commanding position which they occupy in science and in industry both in France and abroad.

Although the diploma may be obtained in three years, technical requirements of industrial life and the necessity for the most thorough preparation on the part of all who desire to pursue scientific research, incite many students to continue a fourth, and sometimes even further years of training. The supplementary years may include a research such, for example, as the required thesis for a *doctorat d'État* (*licence-ès-sciences physiques* required) or *doctorat d'Université*. This is generally pursued in special laboratories

under the direction of a professor who is a specialist in the field selected.

In addition to the institutes serving particularly the industrial necessities of a given region there are institutes and schools of a more specialized character which are in a measure the center of training in special branches of industry. Such are the Institutes and Schools of Brewing, Metallurgy and Mining Industry (Nancy), Tannery (Lyons), Soaps and Fats (Marseille), Petroleum (Strasbourg), Carburants (Montpellier), Paper (Grenoble), Turpentine and Rosin (Bordeaux), etc. These institutes give a diploma of specialized engineer (brewing, metallurgical, and mineral industries, etc.) after an examination taken at the end of three years of study. The courses there given relate to the special industry studied and the programs include problems of industrial application, operations on a factory scale, etc.

These institutes and schools, as indeed all French universities, are freely and very cordially open to foreign students and investigators.

Educational Statistics. In 1926 there were 3,786,000 students in public high schools in America; 346,000 in private high schools.

Two hundred eighty thousand young men and women were in the public colleges; 486,000 in the private colleges.

There were 977,291 teachers in all the schools of the land, public and private.

Two billion seven hundred forty-four million dollars was spent for education of all kinds in America.

The value of school property is $8,125,000,000.

The cost of public, elementary, and secondary education in 1903 was $251,000,000; in 1926, $2,026,000,000.

In 1926 the cost per pupil in regular attendance at the elementary and secondary schools was $102.75. The cost per capita of population was $17.50.

In the rural communities 25.7 per cent of the eligible children are in high school; in the urban communities, 71.1 per cent.

Twelve per cent of rural high schools are now organized on the junior high-school plan; forty-seven per cent of the urban high schools. High-school enrolment has doubled since 1920!

One hundred thousand children are transferred annually from the traditional elementary upper grades to junior high schools.—*The Flathead Messenger*, Kalispell, Mont.

Education proposes to confer on man the highest improvement of which his body, his mind, and his soul are capable, with a view to secure his well-being, to fit him for society, and to prepare him for a better world. Hence, general education is divided into three branches—physical, intellectual, and moral, the last including religious training. The first aims at health, strength, and beauty; the second at mental power and the acquisition of knowledge; and the third at piety, justice, goodness, and wisdom. —C. MARCEL

SYNTHETIC MEDICINES*

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Introduction

Before entering upon a discussion of prescribed length, it is well to state the exact scope to be covered. My purpose is to discuss chemistry as related to the production and the use of synthetic compounds in medicine. Such medicaments may be duplicates of, or improvements upon, natural products, or wholly the results of human ingenuity.

Chemo-medico-synthesis is the ultimate result of centuries of human effort against the ravages of disease. Among the primitive peoples, man began to seek the alleviation of his ills by applying to them herbs and other crude natural products plus much superstition. This practice became monopolized by magicians and priests, who, having no scientific principles to guide them, administered almost every imaginable substance as a medicine, frequently with fatal results. But now and then, among countless failures, these hit-or-miss practitioners of the healing art scored a success, discovering accidentally some natural substance possessing real curative properties and valuable physiological action. Thus came the discovery that an extract of the bark of the cinchon tree of Peru would cure malaria.

Then during the Middle Ages, Paracelsus (1493–1541) turned chemistry to the interests of medicine by the introduction of various inorganic remedies. Henceforth, chemistry's relation to medicine was established, a bond that was firmly cemented by Wöhler's epoch-making discovery of the first synthetic formation of an organic compound, urea, in 1828—and by the memorable labor of Pasteur.

The period for 1828 to 1860 principally marked the theoretical development of synthesis by Wöhler, Frankland, Kekulé, Pasteur, Couper, and many other great savants. With the evolvement of the present system, the structural theory, by Crum Brown and Frankland in 1865–1866, added impetus was given to synthesis. In fact, since then hundreds of thousands of definite compounds, organic and inorganic, have been prepared and cataloged. Now the chemist has possession of a weapon by which he is able to attack nature in her most formidable strongholds, wrest her secrets from her, and utilize them for the benefit of mankind. The entirely empirical discovery of mauve by Sir William Perkins in 1856, the synthesis of the first coal-tar medicine, salicylic acid, by Kolbe in 1874, of indigo by Adolf von Baeyer in 1881, and of the valuable alkaloids are a few of the early triumphs.

It is worthwhile now to glance at the relation of synthetic chemistry to medicine. The pathology of a disease, whether germinal or physiological, is carefully studied; comparison between it and similar ailments is

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "The Relation of Chemistry to Health and Disease."

made, if necessary; and the curative effects of various medicaments are carefully noted. Then the synthesist, in a well-equipped laboratory and with the aid of the accumulated data, commences to modify, tear down, and even create new molecules until he obtains the ultimum curative. His encroachments on the fields of anesthesia, antiseptics, endocrinology, nutrition, and specifics have been in some cases very fruitful, in others, promising, but of such promise that the medical man of the future is given the assurance that he will ultimately have under his absolute control all diseases known today—and this largely through synthetic chemistry.

Anesthetics: General and Local

The present high state of surgery could never have been developed by the surgeon with all his aseptic technic if chemistry had not intervened with pain-alleviating substances, anesthetics, both general and local in their effects. Formerly the patients suffered tortures, for surgery was extremely barbarous. Now they rest unconscious of the scalpel and the saw.

After the discovery of oxygen in 1771, a keen interest arose in the gases. Thus, in 1800, Sir Humphry Davy discovered the fact that nitrous oxide was capable of destroying physical pain. Today, in admixture with oxygen, it is used for anesthesia in dentistry and surgery. In 1846, diethyl ether was noted to possess anesthetic properties. Since then it has become the most important general anesthetic. Its success stimulated a search for newer and better anesthetics. In 1848, followed Dr. James Y. Simpson's discovery of chloroform with its several distinct advantages over nitrous oxide and diethyl ether. A. B. Luckhart and Carter of the University of Chicago discovered, in 1923, the anesthetic properties of ethylene, the nearest approach to an ideal anesthetic—one that can be easily administered, can produce profound coma, and from which the patient can rapidly recover without any ill after-effects.

The chemical composition and the synthesis of the above-mentioned compounds are seen in the following equations representing their formation:

(1) Nitrous oxide, N_2O
Gentle heating of $NH_4NO_3 = 2H_2O + N_2O$

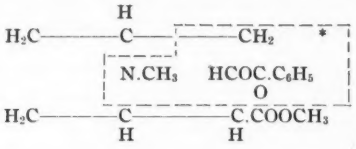
(2) Diethyl ether, $(C_2H_5)_2O$
At 120°C., in the presence of $Al_2(SO_4)_3$, a catalyst, the reaction takes place in two steps,
(*a*) $C_2H_5OH + H_2SO_4 = (C_2H_5)HSO_4 + H_2O$
(*b*) $C_2H_5OH + (C_2H_5)HSO_4 = H_2SO_4 + (C_2H_5)_2O$

(3) Chloroform (trichloromethane), $CHCl_3$
$CCl_3 \cdot CHO + KOH = H \cdot COOK + CHCl_3$

(4) Ethylene, C_2H_4
$C_2H_5 \cdot HSO_4$ heated alone, or with concentrated H_2SO_4, yields C_2H_4,
$C_2H_5 \cdot HSO_4 = H_2SO_4 + C_2H_4$

Local anesthetics having deep penetrability, but lacking irritating, poisonous properties, are another goal. The molecule of a given drug is scrutinized to reveal what particular group of atoms within it is responsible for the desired physiological effect. This is done by working out the molecule's structural formula and testing its different parts. Then follows the work of synthesizing new compounds having molecules built on architectural plans containing only the desired qualities.

The best example of this labor is perhaps that done on the cocaine molecule. Research worked out its structural formula to be



Subsequent study determined that only the portion of the molecule that is marked with a star and set off from the rest by a dotted line is responsible for the capacity of cocaine for deadening pain. The remaining part proved to be dangerous. The result was synthetic alkaloids, quite unknown in nature, with molecules cut to specifications. Examples are betaeucaine and novocaine, better than their prototype, but as yet not ideal.

Antiseptics

In the 17th century, Anthony von Leeuwenhoeck,[1] discovered bacteria and protozoa, but little importance was attached to these discoveries. In the 19th century, Pasteur, while studying fermentation, rediscovered bacteria. Now, however, these minute organisms attracted the attention of scientists. Succeeding research proved that diseases were caused by various tiny organisms. The important question now was how to overcome these microbes. Thus we find that while Pasteur was developing vaccination other men were working on the value of chemicals as antiseptics and disinfectants.

Dr. Joseph Lister, using carbolic acid solutions, introduced antiseptic surgery in 1867. Previously, there were no effective means of combating infections characteristic of surgical operations. In fact, so bad were the conditions that to open a person's body cavity was practically the same as signing his death warrant. Since then most of the modern successful antiseptics have been discovered and perfected in the chemical laboratories. A few that are used are: formaldehyde, phenol derivatives, iodine, Dakin's solution, and hydrogen peroxide. Several synthetic

[1] See THIS JOURNAL, 7, 1671–3 (July, 1930).

coal-tar dyes such as neutral acriflavine, ravinol, gentian violet, and hexylresorcinol are coming to the fore as antiseptics.

Endocrinology

Another important and promising field of chemotherapy is that of the ductless glands, so-called, because, having no special channels or ducts, they secrete directly into the blood their potent incretions, which are thereby carried throughout the body. These endocrinous glands, numerous and of varying importance, regulate growth and metabolism, sexual development and functional activity, and the cardio-vascular, involuntary muscular, and nervous systems, besides having other effects of vital importance in body chemistry. Therefore, their proper functioning is indispensable to the welfare of the body. For this reason, chemotherapy is carefully studying their chemistry and the isolation, identification, and synthesis of their principles.

The greatest advances in endocrinology have been made in the investigation of the activity of the most important glands, namely, the pancreas, thyroid, adrenals, and pituitary.

In 1922, F. G. Banting and C. H. Best of Toronto isolated insulin, the active principle of the ductless pancreas. Later Abel, having obtained insulin in crystalline form, determined, with the assistance of Jensen and Geiling, the empirical formula of the crystals to be $C_{45}H_{69}O_{14}N_{11}S \cdot 3H_2O$. Its synthesis is now awaited. Insulin, essential for carbohydrate metabolism, is extremely useful in controlling symptoms of diabetes mellitus, for it enables the diabetic to metabolize sufficient sugar for the needs of his body.

The hormones of the thyroid and of the medullary portion of the adrenals have been isolated, identified, and both thyroxin, $C_{11}H_{10}O_3NI_3$, and adrenalin, $C_9H_{13}NO_3$, have been synthesized, thus giving medicine powerful, pure remedies. Thyroxin is principally used in treating simple goiter, cretinism, myxedema, abnormal metabolism, and obesity, all resulting from hypothyroidism. A few uses of adrenalin are prolonging anesthesia by constricting the blood vessels, relieving of difficult breathing in asthma, stimulating and supporting the heart, and counteracting Addison's disease.

In the pituitary gland, the anterior lobe (hypophysis) is essential for normal growth, sex development, and the development of some of the other glands, including the thyroid and the adrenals. Robertson obtained tethlin from the corresponding lobe in the ox. Drs. Abel and Rouiller secured pituitrin, another principle, from the posterior lobe (infundibulum) related to the contraction of involuntary muscles and to carbohydrate metabolism. Pituitrin, very useful in obstetrics, but not yet synthesized, has been separated by Dr. Kamm of Detroit into two parts

designated as alpha and beta, respectively, useful in obstetrics and surgery and burns, besides controlling the water content in the body cells.

Nutrition

Man would undoubtedly be immensely benefited if he could master the synthesis of foods and of the essential nutritional factors such as amino acids, enzymes, and vitamins. Only chemistry, by compassing the synthesis of these organic products, can release him from his dependence upon the plant and animal kingdoms for his sustenance. Progressively the end will be reached; one by one the necessary foodstuffs will be prepared, first in the laboratory, later in the food factory.

Emil Fischer's investigations on the sugars has led to the synthesis of numerous simple sugars and to the recent work on carbohydrate metabolism and its pathologic variations found in diabetics. The foundation of modern research on protein metabolism is formed by his work on amino acids. It has been shown that several amino acids found in natural proteins are essential for normal nutrition and health. In the absence of these necessary substances, *e. g.*, cystine and histine, animals become unhealthy, develop definite symptoms, fail to maintain themselves, do not reproduce, and may even die. These disorders may be remedied by adding the deficiencies to the incomplete proteins. For instance, a disease designated as acystinosis is relieved and overcome by administration of cystine, which, by the way, has been chemically identified.

A thorough understanding of the action of even one enzyme might throw considerable light on the various physiological actions that contribute to what we call life. Moreover, the synthesis of such substances would be a boon to the anemic, the dyspeptic, and others. The outstanding work being done on pepsin, the proteolytic enzyme of the gastric juice, although not yet successful, promises future victory for the chemist in this field.

During recent years a great deal of attention has been focused on the causes of nutritional disorders, the avitaminoses, known to be due to the absence of vitamins, so-called accessory food factors. Thus far, six vitamins and their relations to the nutrition, functioning, and development of the body are known, namely:

Vitamin	*Function*
A	Antiophthalmic
	Growth-promoting
B	Antineuritic
C	Antiscorbutic
D	Antirachitic
E	Reproductive
PP	Antipellagric

Notwithstanding what is known concerning these vital nutritive catalysts, the chemist is still confronted with the problems of isolating, identifying,

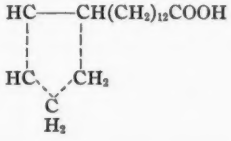
and synthesizing them. The best he has been able to do is to prepare such concentrates as Miller's Bios I and II, Seidell's crystalline picrate possessing antineuritic properties, Eddy's growth-stimulating bios, $C_2H_{11}NO_3$, and irradiated ergosterol, the potent specific for rickets.

These advances promise that we may confidently expect the final artificial production of at least some of the amino acids, enzymes, and vitamins to the undoubted advantages of medicine.

Specifics

The chemist's problem in producing specifics is to secure medicaments destructive to particular germs but harmless to the patient. Here he has two alternatives, viz., (1) he may improve natural remedies, or (2) he may modify some promising compound.

An example of the former plan is the work being done on chaulmoogra oil, used for leprosy. In the Orient, where this disease is rather prevalent, the only medicine has been the crude, unsavory oil taken in through the mouth. The chemist, after studying and experimenting with this oil, has obtained fatty esters which are being used hypodermically more successfully. At the University of Hawaii the research department is striving to obtain a water-soluble fatty ester. Perhaps since the structural formula of chaulmoogric acid,



is now known, the remarkable work done on cocaine may be duplicated.

Paul Ehrlich was the first to succeed by the second method of procedure. Working on the staining properties of aniline dyes, he became convinced that dyes could be very efficient medicinal weapons. Therefore, with this thought in mind, he set to work preparing a specific for syphilis. After 605 failures, covering two years of skilful chemical synthesis, he discovered arsphenamine, his "606" compound, chemistry's greatest triumph in this field. This advent marked the beginning of other brilliant discoveries, for it demonstrated the chemist's power of transforming one form of matter into another more serviceable to man.

Although only two absolute specifics, quinine for malaria, and arsphenamine for syphilis and African sleeping sickness, are known, many near specifics have been prepared. For sleeping sickness "Baeyer 205," "Pasteur 309," and tryparsamide, which is also an important drug for the treatment of paresis, are valuable remedies. Carbon tetrachloride, chenopodium, and thymol are effective anti-hookworm agents. Gentian violet

has a selective action against gram-positive staphylococci, whereas acid fuchin kills Gram-negative bacteria. Ravinol is said to act primarily as an inhibitive for streptococci and staphylococci. Mercurochrome has proved valuable for septicemia.

Among other synthetics having special applications are homatropine, used to dilate the pupil of the eye, and theophyllin, one of the best diuretics.

Conclusion

Thus in a brief survey has been shown the trend of chemistry to provide medicine with synthetic medicaments. Anesthetics, antiseptics, endocrinous principles, specifics, and other synthetic products! Imagine where modern civilization would be without them! Yet only the surface of the possibilities of chemo-medico-synthesis has been scratched. And so great is the progress of this new chemistry that perhaps even those born today may live to see the preparation of synthetic antitoxins, laboratory substitutes for all endocrinous incretions, and even the conquest of cancer and tuberculosis!

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WINNERS IN EIGHTH "WHAT IS WRONG?" CONTEST

The winners in the eighth and final "What Is Wrong?" contest[1] were as follows:

Five-dollar award.—John N. Faick, Missoula, Montana.

One-dollar awards.—Donald Walther, Sunbury, Pennsylvania; Elvira Hernandez, El Paso, Texas; Frank Kos, Chicago, Illinois; Kenneth Koenig, Litchfield, Montana; Evelyn Cramer, Bennett, Colorado.

[1] See THIS JOURNAL, **7,** 1166 (May, 1930).

CHEMISTRY AS AN AID TO CULTURAL ENJOYMENT*

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Chemistry and chemists were once regarded as direct agents of the devil. This, however, is a chemical age. Today we live and have our being as a result of chemical processes. William Haynes, writing in the *Science Monthly* for May 13, 1927, has said: "Today, chemistry is not only a systematized and coördinated body of facts; it is also the tool and toy of the man of the street. In the market places or by his own fireside a man is deaf, dumb, and blind without at least a working knowledge of the science. It is, as Br'er Rabbit once said, 'de mos' kulturines' t'ing in de world.'" Chemistry is the science of the transformation of matter, and is enormously productive, both of new knowledge and its applications.

It is difficult, perhaps, to realize how profoundly chemistry influences our conception of culture and how invaluable an aid this science is to our arts. We travel to Europe, roam through art galleries and look at statuary, we applaud famous musicians, read the thoughts of men who lived and died two hundred years ago, we lose ourselves in the dim aisles of great cathedrals, and feel more cultured in the end. But it is not often that we give a thought to the science that has made these things possible. Chemistry seems too prosaic, too commercial and industrial to be involved in the creation of beauty. Let us consider here, however, the part that chemistry plays in the arts that go to make up culture.

In the first place, chemistry has done much for literature. A few centuries ago, before the invention of printing when there were no books or newspapers and little correspondence, civilization was at a far lower ebb than it is now. Chemistry's important part in this enormous development has been chiefly in the production of paper and inks.

Less than one hundred years ago, paper was entirely manufactured from cotton and linen rags. Now however the supply of these is insufficient to meet the demand, and less pure forms of cellulose from straw, grasses, and wood are used. The chemist is called upon to separate the cellulose from its natural state by boiling it with calcium bisulfite. The fibers thus obtained are chemically bleached, washed, and colored if desired, and are then felted together by machines. Chemistry's next aid in the process is called "sizing." A solution of alum and rosin soap, or sometimes powdered gypsum, white clay, or similar substances are added to give body and fill up the pores.

Black or blue-black inks are the commonest in use for writing purposes, and are composed of an extract from gall nuts with ferrous sulfate and an acid to keep the iron in solution. A dye is usually added to make the writing show more distinctly. Some common inks are simply solutions of

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "The Relation of Chemistry to the Enrichment of Life."

coal-tar dyes in water. Red ink is an aqueous solution of eosine. Logwood extract and potassium chromate form a black ink which is easily transformed into violet when it is boiled with alum and copper and filtered.

Black printing inks vary in composition with the type of printing to be done. They are all pigments ground in oil or varnish. The pigment used in plate ink is generally acid-washed bone black, made by the destructive distillation of bones, or vine black, made by a similar distillation of almost any vegetable matter. Manganese borate is added as a drier. Lithographic and typographic inks contain organic lake pigments made from organic dyes precipitated on aluminum hydroxide, or carbon black made by the partial combustion of some fuel gas. These pigments are ground into a vehicle of linseed oil varnish, rosin oil, or petroleum oil containing dissolved paraffin.

It is not so easy to put one's finger on chemistry's contribution to music, though it would be safe to say that there is no instrument made in whose manufacture the chemist has not had a part. Often this part is in the form of a varnish, in the preparation of cords for a stringed instrument, or merely in the production of the glue that cements its parts together.

The phonograph, however, owes more to chemistry, for records are made by a process chiefly chemical. The record blank is a tablet of soapy wax cut in fine spiral grooves. This is dusted with graphite to make it electrically conductive and is then slowly rotated in a copperplating bath. A homogenous deposit of copper having thus been grown, a whole series of negatives is produced from the original record. Two classes of materials are used in the common breakable type of record: rosins and gums (of which the principal example is shellac) and various mineral fillers. This composition is pressed into records in steam-heated hydraulic presses. Flexible records composed principally of celluloid are also made. They are exceptionally free from surface noises, but are not so wear-resisting as wax. The cultural value of the phonograph cannot be over-estimated. Such organizations as the National Gramophonic Society of England with similar societies in the United States and Japan are eloquent of the part it is able to play in the musical development of the individual and of the community, and the phonograph is now being used as an educational agent for foreign language instruction in many schools.

Art is perhaps more reliant on chemistry than are literature and music, for the manufacture of paints and engraving inks is carried on entirely by chemists. Chemicals have further proved an invaluable aid to art in the restoration of art treasures and their preparation for museums.

Paints contain pigments and glues or gums, and are softened with glycerol or water in the case of water colors, and with oil for oil paints. The pigments are added in powdered form to drying oils—usually tung, poppyseed, walnut, or linseed. Opaque whites are chiefly derived from com-

pounds of lead or zinc; red pigments are oxide of iron and red oxide of lead; ultramarine blue occurs naturally as lapis lazuli but a variety of shades may be produced by the action of the chemicals upon it; black pigments are usually some form of carbon. Hydrated oxide of iron containing marl yields beautiful brown pigments when ground. Among the organic pigments are those obtained from natural sources, such as annatto, indigo, and cochineal, but these are rapidly being replaced by aniline colors from coal tar. The choice of a pigment depends on its chemical and physical properties. Through scientific progress an almost unlimited variety of colors is now available.

Photography can also be considered art in precisely the same way that any graphic process can be so regarded when it is dealt with by an artist.

Photography is the art of producing pictures by the action of light upon chemically prepared or sensitized materials. The practice of photography depends on the sensitiveness of silver salts to light. The developing bath and the production of a positive print from a negative are chemical processes. There have been great advances in the chemistry of photography, in negative developers and printing papers, though color photography is still in the experimental stages.

Another art closely related to photography is that of the motion picture which is now bringing instruction and entertainment to the people on so large a scale. The motion picture can never displace the legitimate stage completely, and many rate but low the histrionic value of such productions, but it must be taken into consideration that the screen is taking the place of the stage in many lives and that its influence has been said to transcend that of the newspapers. Classics of literature have been combed for screen material, historical photoplays have exercised a distinct educational effect and finer wit is finding its way into the movies, accompanied by the development of a better sense of humor.

The millions of feet of film consumed in the making of moving pictures annually make necessary the operation of large chemical laboratories at many studios. Here the film is made, the negative film from the camera is developed, and hundreds of positive prints are produced. The work is of a highly specialized nature and is exceedingly important.

Again, chemistry is at the root of architecture. With the development of new building materials comes a demand for a new style of architecture. Portland cement, known in the time of the ancient Romans, has been rediscovered in comparatively recent times and is now one of the most important of building materials. Glazed building tiles are another modern development and have proved nearly perfect. Bricks also, baked in pottery kilns at a very high temperature, are popular for building purposes. Artificial abrasives have been invented by chemists for the grinding, cutting, and the polishing of stone. With new transparent lacquers, baked

japans and enamels, paints and varnishes, wall papers, floor coverings, rubber tiling, and leather upholstery comes a change in interior decoration. Thus chemistry is beautifying our environments.

As the chemist provides not only many of the materials used by sculptors, but also the finishes, moulds, and methods of coloring, he also has a finger in the pie of the plastic arts.

The plaster of Paris used so extensively in making statuettes and casts is calcined gypsum or calcium sulfate. One of the earliest sculptural mediums used in Egypt, Greece, China, and India is terra cotta, a chemically prepared clay.

There are two important methods for the making of moulds in which a statue is cast. One is the "packed sand" mould, in which a very fine composition of clay, silica, and alumina, called French sand, is used. The other, and the method most in use, is the *ciré perdue* which demands gelatin for the negative, wax for the replica, and a semi-liquid composition of silica, plaster, and other chemicals which can resist high temperatures. Glue and gelatin moulds which are greased with a mixture of stearine and kerosene before the plaster is poured in, are also used.

Finishes are of the greatest importance. They must not only be appropriate to the material and to the subject portrayed, but must also be such that they do not create a surface harmful to modeling. Marble is polished with natural or artificial pumice stone and washed with oxalic acid reduced to the consistency of table salt. Bernini was one of the first sculptors to finish his marble in this way, and Canova followed his example. A chemical composition of waxes and white spirit varnish is much used in ivory carving, and the careful polishes given to wood are chemically prepared. The exquisite "patina" permitting of the finest detail and range of color in bronzes is due entirely to the chemical composition of the bronze. Bronze must be cleaned with nitric acid before it is finished.

There are various ways of tinting plaster casts so that they resemble bronze or terra cotta. One of the most common is the oil paint method. A coat of shellac is given as a prime, followed by the application of oil paint with a little dryer.

The possibilities of a glazed sculpture are just being investigated. The ancient Egyptians used pigment on their sculpture direct with a very decorative effect. But the modern sculptor interested in color is working with his chemist to make a glaze of quality which is thin enough to hide no detail of the modeling.

Ceramics is an art closely akin to sculpture. The basis is clay of varying coarseness dependent on the pottery to be produced. The materials are ground fine, made into a slip with water, and partially dried to a plastic state, in which state they are formed by pressing, throwing, and moulding into endless varieties of forms which we see daily. A glaze is

given to the surface by covering it with a fusible flux or glass containing lead for some wares, and with a glaze composed chiefly of feldspar for porcelain.

Wilson analyzed Berlin porcelain and found it to contain principally silica and alumina with small amounts of oxide of iron, lime, magnesia, and potassia. A flux used at Sèvres in much porcelain painting consists of silex, borax, and minium. The coloring matter is exclusively chemical and the modifications of tint are due to variation of the proportions or the regulation of the heat intensity.

The chemistry of all porcelain work is largely the same, but even slight differences in the composition of the glazes may alter the character of the ware.

The manufacture of glass and the production of the beautiful Bohemian and Venetian glassware are closely related to that of porcelain. Glass occurs in nature as a volcanic effusion known as obsidian, but man prefers to let the chemist make it for him rather than use nature's. The colors in glass are due to metallic oxides.

We have followed chemistry through its relation to the major arts: literature, music, art, drama, architecture, sculpture, and ceramics, and have seen what an integral part it has in the cultural development of the world. Not only does it have these direct bearings upon civilization, but others more or less indirect. Travel, for example, is one of the most cultivating processes of our time, and one has but to ask himself the question, "What would travel be without chemistry?" to realize its vital share in ships and trains and automobiles—in all, in fact, that makes for transportation.

But one of the chief aids of chemistry to cultural life and enjoyment is that it has helped to put culture in the way of the masses. Books have brought literature, drama, art, sculpture, and travel to the people, and the gramophone and radio have brought music and oratory within the range of all. It is in this sense that Dr. Norman Campbell has written that science is the "noblest of the arts."

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A DIRECT READING VOLUME-METER

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The volume-meter described below may be employed to determine the volume of irregular solids with a high degree of precision. The apparatus consists of a cylinder *P* (see Figure 1) 4.8 cm. in diameter and 12 cm. long, the bottom of which is drawn out into a tube *BD* 10 cm. long, containing a bulb of 10-cc. capacity. A milled-in glass stopper with an outlet tube *MN* is inserted in the top of cylinder *P*. Tube *MN* is 30 cm. long, 5 mm. in diameter and graduated into fiftieths of one cc. A leveling bulb of mercury attached at *D* completes the outfit.

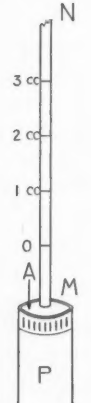

FIGURE 1.—SHOWING CONSTRUCTION OF VOLUME-METER

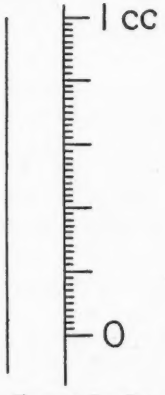

FIGURE 2.—DETAIL OF TUBE *MN*, SHOWING 50 DIVISIONS PER CC.

The procedure for making determinations is as follows. Flask *P* is filled with water and the stopper containing tube *MN* is inserted. By means of the leveling bulb the mercury is brought to mark *B* on outlet tube of cylinder. This causes water to rise in tube *MN*. A reading is made of the height of the water column. The leveling bulb is now lowered until water falls considerably below stopper *A*, the surplus collecting in bulb *C*. The stopper and attached tube is now removed and the sample whose volume is sought is now inserted into the cylinder. The stopper is then replaced and the mercury brought back to mark *B* by means of the leveling bulb. A second reading of the water in *MN* is made. The difference of the two readings of column *MN* gives the volume of the solid.

UTILIZATION OF AGRICULTURAL WASTES*

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Undoubtedly one of the greatest services of chemistry to mankind is the utilization of waste materials which are absolutely worthless without treatment, but which are often transformed by chemistry into valuable by-products. In many industries this chemical use of wastes has, for several years, been highly developed; nevertheless, there is a chance for greater development as scientists make progress. Especially is this true of agriculture, perhaps the most important of all industries. Recently the advances of chemists in their research for profitable uses for such now worthless things as straw, corncobs, peanut shells, and cornstalks are interesting scientifically minded America. All over the world, in fact, research men are attempting to find profitable uses for the great agricultural by-products.

By far the most common use of corncobs at the present time is as a fuel. But analysis shows the cobs to contain a great deal of moisture and to possess little heating value. Clearly some better use should be made of them. Many farmers grind up their corncobs and feed them to the cattle, but such a use is uneconomic, because corncobs have almost no food value. Chemists, attempting to find a use for this waste product, discovered that if the corncobs were heated in a closed retort and the resulting liquids distilled, the final products obtained would be approximately the same as those from a similar treatment of wood. Such a discovery is important in face of the fact that the supply of wood for distillation is decreasing rapidly.

But by far the most interesting treatment of corncobs is that by which furfural is produced. Furfural has been known for a long time as a light yellow, oily substance, the chief value of which was as a laboratory curiosity. Until experimenting proved that it could easily be derived from corncobs and oat hulls it sold for $30 a pound, and often for more. The number of practical uses for furfural is now almost infinite. Embalming fluid, for instance, may be manufactured with furfural employed as a substitute for formaldehyde. The fabric so often used on airplane wings must be treated chemically with "dope," a substance which can be manufactured from furfural. This golden furfural makes a fine antiseptic for the treatment of seeds. It features in the making of several anesthetics. Recently chemists have found that it is a good ingredient for the popular quick-drying lacquers. Aqueous solutions of furfural are very fine preservatives for anatomical specimens. It is found to be a possible new raw material for the dye industry, and, by itself, it is a very good varnish remover. It is also an excellent solvent for such materials as nitro-cellulose.

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "The Relation of Chemistry to Agriculture or to Forestry."

During the last few years, a series of hard plastics produced from phenol and formaldehyde have come upon the market and practically revolutionized certain industries. These substances are sold under trade names such as Bakelite and Redmanol. Almost no change is found in the plastic if furfural is used to replace the formaldehyde. All such plastics demand some inactive filler in order to keep the price from becoming excessive. In the laboratory, ground corncobs have been used for the filler, together with furfural for the formaldehyde, and excellent results have been obtained. A very inexpensive process is used. It is a simple treatment of the ground corncobs with hydrochloric acid and phenol. The hydrochloric acid liberates furfural from the cobs; the furfural reacts with the phenol to form the final product; and the final product contains the excess of ground cobs as a filler.

Some furfural compounds are used in anti-knock gasoline, and furfural by itself may sometimes become an extensive gasoline substitute, although its present price, fifteen cents per pound, makes this use impractical. If all the corncobs, peanut shells, and cottonseed hulls in the United States were, each year, made into furfural, we should never be faced with a gasoline shortage. Other furfural compounds are used in rubber curing, where they act as accelerators. These varied and extensive uses of only one of the many products obtainable from corncobs, not to mention the many other agricultural wastes, show the immense importance of such chemical research.

Furfural is by no means the only product that can be obtained from corncobs. A strong glue is made by digesting the cobs with water under pressure. The substitution of dilute mineral acids for the water changes the resulting product to xylose, which is a sugar. Xylose is particularly valuable as a sweetening agent in the diet of diabetic patients, since it is not assimilated to any extent in the body. Lactic acid, acetic acid, alcohol, and succinic acid may all be easily obtained by fermenting the xylose sirup.

Another valuable derivative of corncobs is oxalic acid, obtained by the fusion of the cobs with caustic soda. Oxalic acid has a multitude of uses, being employed in the dye, tanning, explosive, ink making, and laundry industries, the production of artificial silk, celluloid, and other things.

Corncobs may be used in place of spent tan bark in the manufacture of white lead. Ground cobs also make a suitable substitute for ground cork in the production of linoleum. A flour obtained by grinding the cobs extremely fine makes a good filler for diabetic food, plastic wood, and many similar substances. Besides these, there are a great many minor uses for corncobs, such as in the manufacture of sweeping compounds, in the curing of concrete, in making punk and incense, in the smoking of meat, and in an almost limitless variety of rather unimportant processes.

Next to corncobs, possibly the greatest waste product on our great Middle Western farms is the cornstalks. Scientists have proved that cornstalks have little or no beneficial effect when they are plowed under the soil, and that, as a food, they may be harmful to cattle.

If the stalks are shredded, beaten, and cut up into small fiber bundles almost like pulp, and then cooked, a sticky substance is secreted; which substance, when the material is run through rollers, holds it together in the form of wall board. This wall board is very light in weight; it is an excellent heat insulator; and it is thus extremely useful in the building industry. It has every advantage over the old-time wood lath; it also makes a fine sheathing, not only because of its insulating properties, but because it makes a stronger wall than the older sheathing process. This insulating value is equal to that of the sheet cork now used in refrigerator construction. The yield per ton of cornstalks is quite high, and the cost of production promises to be reasonably low; therefore, it appears that cornstalks may become an economic good of no mean importance.

By slightly varying the manufacturing process for this wall board, we obtain a very hard, strong material. This denser material can be used for many things where the softer insulating board would be quite unsuitable. A few possible applications are for paneling in automobile bodies, Pullman cars, and truck bodies. The cost of production for this type of board is somewhat higher than that for the first type.

If gypsum is used as one of the ingredients in the manufacture of the wall board, the resulting product is almost perfectly fireproof. It has advantages over the pure gypsum board, since it is lighter in weight and is somewhat easier to nail into. The pulp used in making these wall boards may be molded into a variety of shapes while wet, and will become hard and quite strong upon drying. The sale for novelties made in this way is large, and the resulting *papier mâché* industry is rather important.

Another simple change in the process causes the pulp to dry out to a hard, dense substance not unlike vulcanized fiber. This material can be either molded or machined, and is used to make knife handles, gears, and knobs. It is a good electrical insulator, and possesses surprising strength, so that it can well be used in the manufacturing of switch buttons and similar electrical apparatus. This material is on the market under the trade name of maizolith or cellulith.

But there is one use for cornstalks which easily eclipses all others. It is the manufacture of paper. Attempts to use cornstalks in this industry date back as far as the seventeenth century. At present, because wood pulp is becoming rather scarce, the production of cornstalk paper is assuming a new importance. Under quite a high steam pressure, the stalks are digested with a regular paper chemical. Then the pulp is beaten and the fibers which are too large are removed. The final steps

are bleaching the pulp with a solution of white powder and rolling it into sheets. All types of paper, from coarse, thick filler for egg cases to fine, bleached writing paper have been produced. Most efforts are being bent toward the economic production of newsprint. Cornstalk paper pulp has proved very satisfactory, and the paper is already used quite extensively in some localities.

Alpha cellulose, an important raw material in the manufacture of rayon, or artificial silk, is obtained by especially purifying the cornstalk pulp. The rayon manufactured from this pulp is perfect, and alpha cellulose is now being produced commercially from cornstalks in a factory in Illinois. This cornstalk cellulose suggests a great field of possibilities. A gunpowder company is using it in the manufacture of smokeless powder. Another explosives manufacturer is experimenting with the fibers as an absorbent for dynamite. Like the corncob products, cornstalk cellulose may be incorporated into special foods for diabetic patients. Clay mixed with cornstalk fibers has been found to make an excellent building material. Ordinary brick is heavier than this new building block, and considerably more expensive. In addition to these products, there are many things now made from derivatives of other celluloses which could just as easily be made from the cornstalk cellulose.

But cornstalks and cobs are by no means the only agricultural waste products which chemistry has made valuable to man. This limited space will not be sufficient to deal as extensively with the other accomplishments of science in this field, but a few of them should be mentioned.

The cheese, or casein, industry is steadily becoming more and more important in the United States. Formerly almost all of the milk from our great dairy herds was skimmed, the cream, or butter fat, hauled away to the creameries, and the skim milk used wastefully without getting the maximum utility from the chemicals contained in it. But cow's milk contains almost as much casein as it does butter fat, and this casein is an extremely valuable by-product if it is treated properly. By means of coagulating the casein with a dilute acid a precipitate is formed, which precipitate, after being washed and pressed, becomes our modern cheese. This cheese has a very high food value. The remainder of the milk, mixed with the washing water and called whey, is fed to the hogs just as the skim milk was before chemistry came along to make use of the casein. By treating this casein with different chemicals, we obtain glues, cements, putty, and paints. Casein, together with formaldehyde, is used in a treatment for waterproofing paper. Containers made from this treated paper are used for the products of many present-day industries.

In the meat-packing industry, chemistry has made possible the profitable use of many wastes which otherwise would be absolutely worthless. Meat packers, with the help of science, can thus produce glue, soap, and a

variety of other products. Thus a Midas-like touch has transformed the scraps of an industry into common and important articles. Chemistry takes beef fat, formerly a financial loss, and makes from it oleomargarine, an important butter substitute. It takes the wastes of the fruit-growing industry and turns them into lemon extract, cider, vinegar, and similar products. It takes the unsalable potatoes and makes alcohol from them. It makes the same valuable product from the waste of the cane sugar industry, at an almost negligible expense.

The number of agricultural by-products made with the aid of chemistry is too great to be gone into any more extensively here. Suffice it to say that almost anything from face powder to varnish can be made from the wastes of the corn farmer alone, and the possibilities in the other branches of the industry are equally great.

Up to the present, experimenters have barely touched the possibilities of chemistry as a salvager in agriculture. The main body of the work is yet to be done. It has a romantic appeal which should call to any one who is interested in voyaging into the unknown, and returning with the golden fleece of worthwhile information for his fellowman. We can powder our faces and run our automobiles with peanut shells now! With the aid of chemical research, materials we even now consider worse than useless may, sometime, sustain the whole human race.

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Factory Ventilation Prevents Chrome Poisoning. New methods of ventilating worked out by the U. S. Public Health Service may save thousands of workers in automobile factories from serious nose trouble, now often caused when accessories and trimmings on the car are treated to a coat of non-tarnishable chromium.

Hydrogen, carrying a slight amount of chromic acid, is released in the plating process, Dr. L. R. Thompson of the Public Health Service explained to the House Committee on Appropriations, and if this passes a man's nose, it may be drawn up in the nose and be deposited on the septum.

"If this continues, in a short time he loses the entire nasal septum. . . Some automobile companies have tried ventilation, but the methods they were installing would draw the air straight up rather than across the vat. . . We showed them that if they would draw the current of air across rather than up it would relieve the situation."—*Science Service*

IS THE USE OF GAS IN WARFARE JUSTIFIABLE?*

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"All's Fair in Love and War"

Weary men stumbling and floundering in the mud and slime of No-Man's-Land, advancing in the face of a terrific bombardment; bursts of shrapnel raining torrents of deadly steel upon their heads; machine guns and rifles sending a steady stream of hot lead to greet them as they pass through the barbed wire entanglements; shrieks of pain and cries from falling men; heavy shells exploding in their midst, hurling arms, legs, and bits of dismembered bodies high into the air; wounded men groaning on the wet ground, ugly lacerations with blood oozing from them showing on their bodies; then hours of suffering before the stretcher-bearers carry the disabled victims from the field; every jolt sending stabs of pain through the torture-wracked bodies on the frames; later the amputations, probings, and stitchings in the hospitals, the daily agonies through which every wounded man had to pass: such is a glimpse of modern warfare and its effects.

Years afterward, the men who have survived the battle are at home. Some are blinded, some have limbs missing; many are afflicted with tuberculosis and other diseases contracted upon the battlefield; a great number are suffering in some way or other, victims of the terrible weapons of modern warfare.

Human words can hardly picture the incredible amount of suffering which resulted from the use of high explosives in the World War. The two paragraphs above give at best an inadequate picture of the effects which were produced by the rifles, machine-guns, and heavy artillery of the contending armies. The past war witnessed the employment of almost every conceivable sort of standardized weapon. Yet no outcry was made among the nations of the world that these implements of warfare were in any way inhumane. Although it had been generally known for the past fifty years that high explosive shells were the most cruel weapons invented, no voice was raised in protest against them and they continued in the World War to be used on a scale hitherto unknown. So-called human beings believed it perfectly fair and humane to blow their fellow-men to bits or to send them home from the war to suffer for the remainder of their lives.

But when the Germans first introduced a new weapon in the form of poison gas against the Canadian soldiers at Ypres on April 22, 1915, a wave of horror swept over the world. Augmented by means of effective propaganda distributed through the newspapers of the Allied Powers, this wave steadily grew into one of profound aversion to the use of gas in war-

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "The Relation of Chemistry to National Defense."

fare. The human mind naturally recoiled from the exaggerated tales of soldiers writhing in hideous agony, their faces blackened and distorted by the terrible choking death which had seized them in its grasp. Millions of people pointed aghast at Germany's violation of an international agreement made at The Hague in 1907 which debarred the use of projectiles capable of producing poisonous or deleterious gases.

Was Germany justified in employing gas during the late war? The majority of people, obviously misled concerning the horrors of chemical warfare, and basing their statements upon doubtful evidence, assert that her conduct was atrocious. But if one argues from a strictly chemical, medical, and psychological point of view her use of gas was entirely legitimate. War experts, chemists, pathologists, men who know the truth about gases, state that there has never been a more humane weapon. In order to arrive at a statement as to whether or not the use of gas in warfare is justifiable, it is necessary to know some of the characteristic properties of gaseous weapons.

War gases are, in general, divided into four groups according to the physiological effects which they produce. The first class, pulmonary irritants, chief among them chlorine, phosgene, and chloro-picrin, contain those gases which are poisonous when inhaled, but which have no permanent effect upon the skin. They produce an asphyxiating death by reason of pulmonary changes. Coagulation of the blood occurs which limits the action of the heart, causing the lungs to receive an insufficient supply of blood, and thus indirectly producing suffocation. Chlorine also attacks the lung tissue and subjects it to bacterial invasion. Pulmonary gangrene or pneumonia may then end the life. Gases which owe their lethal power to their intrinsic toxicity are classed with the group above. These gases, such as arsine, phosphine, hydrocyanic acid, and several others either produce no lesions or else very slight ones which heal rapidly in cases where death has not occurred. The entrance of asphyxiating gases into the lungs can be prevented, however, by passing them through respirators containing alternate layers of charcoal and soda lime, which respectively absorb and react to neutralize the gases. Other reagents are used in conjunction with the soda lime in certain respirators; hexamethylene tetramine, for example, reacts with phosgene to render it harmless. As all troops can readily be protected by respirators which contain the above materials, the use of these gases is rendered rather obsolete.

Gases of the second group, known as lachrymators or tear gases, were just beginning to be used on a large scale when the war ended. Gases of this group are poisonous only in very large concentrations; however, one part of gas in five million parts of air can cause temporary blindness. Since tear gases will spread over an area several hundred times as great as that covered by most asphyxiating gases, it is possible for a single

aviator armed with lachrymatory gas bombs to render an entire regiment of infantry helpless by their use. Yet in twenty-four hours every infantry man will again enjoy perfect health. The lachrymators, including diphosgene, xylyl bromide, monochloroacetone, bromoacetone, and bromoacetic ether, can be rendered harmless by wearing a respirator, or even tight-fitting goggles.

The sneezing or sternutatory substances comprising the third group closely resemble the lachrymatory gases in their general effect. They consist of finely divided poisonous smokes, mostly arsenic compounds, which in small concentrations cause intense irritation of the nose, throat, and respiratory channels. These compounds are decidingly toxic in large quantities, producing the after-effects of arsenic poisoning. It is exceedingly difficult, however, to concentrate them in sufficient quantities to be fatal; hence, casualties produced by these smokes invariably recover after a two- or three-hour period of temporary discomfort, marked by vomiting, nausea, and certain nervous phenomena.

Concerning the sternutatory gases it must be stated that at present there is no respirator capable of absorbing or filtering out all of the smoke which enters, although most of it can be removed by employing a partition of felt in the respirator. Upon reaching the nose this unabsorbed smoke occasions sneezing to an extent which necessitates removal of the mask, thus rendering the wearer susceptible to asphyxiating and toxic gases which are sometimes tactfully mixed with the sternutatory compounds.

Introduction of dichlorodiethyl sulfide or "mustard gas" by the Germans in 1917 revealed the possibilities inherent in chemical warfare. This gas, in reality a liquid, is included in the fourth group, the blistering compounds. The vapor of this liquid is not only poisonous when breathed, but it also produces vesicant or skin-burning effects that range from a small reddening to serious blisters which are extremely painful and incapacitating. These blisters, however, if treated promptly, rarely cause death or permanent scars but keep a soldier out of action for weeks. Mustard gas attacks the eyes, throat, nose, and lungs, but it is doubtful whether it leads to bronchitis or pneumonia as has been claimed. This gas was used on a greater scale than any other chemical weapon during the late war. It remains to be seen, however, whether it will be the most important lethal gas in future struggles, since research staffs of various governments have progressed far in devising protective clothing to prevent the vapors of this compound from reaching the skin.

After considering all of the above, some question may naturally exist in the mind of the reader as to why gases are used in tactical maneuvers if they are not capable of producing death in all instances. In the first place the slaughter of men is not the easiest or quickest way to incapacitate an army. A wounded or severely gassed man proves infinitely more detri-

mental to an army than a dead man; the former becomes a constant source of worry and expense to his government; he is a live casualty for a few weeks at least and therefore a liability. In warfare it is the live casualties which count the heaviest. Gas leads to a larger number of such casualties than any other weapon of combat and is therefore exceedingly effective. It can penetrate fortified places against which shells would have little effect. In addition, gas can be used as effectively at night as in the daytime and is extremely useful in that it can be employed as a weapon of surprise. Aside from the casualty-producing end of chemical warfare there is the need in certain tactical maneuvers for a weapon which will be only temporary in its effect. The lachrymatory and sternutatory compounds prove exceedingly capable in fulfilling this requirement.

Then, too, there is the property some gases possess of remaining for a long time on objects upon which they have been sprayed. These persistent compounds, chief among them mustard gas and certain of the lachrymatory substances, impregnate the soil and linger for days, thereby rendering the ground absolutely untenable. Persistent compounds of an asphyxiating or lachrymatory nature force a soldier to wear a respirator almost continuously, thus enormously decreasing his fighting efficiency. The most important use of the persistent gases is to create a large number of disabled soldiers in a defending army a few days before an attack, thus materially reducing its effective strength.

The psychological reaction produced by gas is very pronounced. It is the fear of the unknown in gas that causes a lowering of morale among soldiers. Among uneducated people it occasions extreme terror and agitation. The only true value of lethal gas lies in this moral effect, the dread which it inspires and the fact that it can be used as a weapon of surprise. In addition to the above items there remains the fact that gas is very economical. The cost of all the gas employed by the Allied armies amounted to only one-two hundredth of the entire expenditure.

The major argument against gas seems to be that it is inhumane. Possibly the following quotation from General Hartley's report to the British Association may answer in part this contention: "The general impression that gas is an inhumane weapon is derived partly from the German breach of faith in using it contrary to the Hague Convention, and partly from the nature and number of casualties in the earliest cloud attacks which were made against unprotected troops."[1] No implement of warfare is humane, yet if necessary we can say the most humane weapon is that which leads to the attainment of a military object with the smallest amount of human suffering and death. Statistics are invariably boresome; however, they may shed some interesting light on the relative humaneness of gas and other weapons. Of the 6,264,512 men wounded

[1] Lefebure, Victor, "Riddle of the Rhine," The Chemical Foundation, Inc., p. 240.

by shells and other weapons among the American, British, and German armies 2,552,931 or 40.7 per cent died. Among the 330,396 gas casualties 9763 or 2.9 per cent were fatalities. According to these figures gas is approximately fourteen times more humane than other weapons.

Most civilians, unacquainted with the horrors of warfare, when talking about gas describe it as causing infinitely more suffering than shell wounds. Yet there is no comparison existing between the amount of suffering caused by gas and that caused by shell and rifle fire. Perhaps a statement from J. B. S. Haldane, biochemist of Cambridge University, would not be amiss in clearing up this point: "Besides being wounded, I have also been buried alive, and on several occasions in peace time I have been asphyxiated to the point of unconsciousness. The pain and discomfort arising from the other experiences were negligible compared with those produced by a septic shell wound."[2] Soldiers of the American Legion, who faced both shell fire and gas, are almost unanimous in advocating the use of the latter in future wars.

A great deal of criticism has been showered upon gas on account of the alleged horrible after-effects. Almost any ailment that came to a man in the late war was attributed to gas. So, too, if a man became insane or blind his case was explained by the fact that he had been gassed. Statistics show that out of the thousands of gassed men in the World War only a few suffered any permanent effects. Of the 9972 American soldiers who received permanent disabilities gas was responsible for only 33 cases; other weapons for 9939. Out of the 274,217 battle casualties among the American Expeditionary Forces four only were blinded by gas. As for the statement that gas was the cause of most of the cases of tuberculosis among soldiers, Dr. Albert P. Francine, one of the best informed authorities on tuberculosis and gas, in testifying before the Senate Investigating Committee, said that gas probably tends to prevent the disease rather than to produce it.[3] In the epidemic of influenza immediately following the war it was a significant fact that soldiers who had been gassed were not stricken.

The childish argument has also arisen that gas has taken all the glory from warfare. War is a grim horrible business. When fighting, a combatant is not concerned whether the way he kills or captures an opponent is fair or foul; his primary object is to conquer his enemy.

Should gas be abolished in future wars? Obviously not. It would be a wickedness to prohibit the use of a weapon which is so remarkably humane. Improvements in the use of gas will make it even more humane, since it will be either more quickly incapacitating or more quickly fatal. Gas

[2] Scammell, J. M., "Outlawry of Poison Gases in Warfare," *Current History*, **30**, 403 (June, 1929.)

[3] Witten, George, "Humanizing War," *Outlook*, **144**, 530 (Dec. 22, 1926).

promises to do for warfare what chloroform has done for surgery.[2] There will be no more nauseating horror of blood-bespattered shambles and the stench arising from shell-blasted bits of decaying humanity. The hideous memories of crunching bones pierced by charging bayonets will be gone. Instead we can expect the capture of unresisting, pathetic groups of sneezing, weeping, vomiting soldiers, who can be restored to perfect health by a ten-minute dose of dilute chlorine. War will be more at a distance; personal combat will be lessened.

In concluding we may say that it is foolish to believe any nation will hesitate to use gases in future struggles. Gas has proved itself far more humane, effective, and economical than any other weapon. It has developed into an indispensable implement of attack and defense and there is no doubt that it will be the chief weapon of the future.

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Potash in Australia. With the object of testing the possibilities of Lake Eyre, in South Australia, as a source of potash salts, Mr. C. T. Madigan, lecturer in geology at the University of Adelaide, is visiting that district. Mr. Madigan is making the visit with the chief object of establishing that it is possible to motor on the lake. If that can be done, it is the intention of the Department of Mines to sink bores to ascertain if salt deposits are present. Several bores to a depth of 30 ft. will be sunk by Mr. Madigan, and if the work proves satisfactory, the Department of Mines will let down bores to a depth of 1000 ft. It is hoped to reveal the presence of potash salts. There are no known deposits in Australia, all stocks being imported from Germany. Mr. Madigan will be accompanied by Professor J. A. Prescott of the Waite Agricultural Research Institute.—*Chem. Age*

CHEMISTRY AND ESTHETICS IN THE HOME*

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The latest development in the chemistry course has been the assignment of an essay on "Chemistry and Esthetics in the Home." Do not let the title overwhelm you. Surely the word "esthetics" is within the scope of a high-school student. But to be quite honest, when I first heard the title it floored me. I wondered how I could attack such a stupendously heavy subject. But after I had consulted a dictionary and browsed about among reference books, I was enthusiastic over the topic.

The first phase that suggested itself was color. Modern homes contain a riot of it. You see bathrooms in orchid and black, pale blue or rose; curtains are almost any shade; walls are tinted brightly. Sun parlors are bright and cozy as much because of their gaily painted woodwork and dashing cretonne as by the sunlight which is their boast. Even the magazines on the table show the result of the "color craze." "Perhaps," I thought, "this topic will not be as formidable as I expected. Color alone has made homes beautiful. If chemistry is responsible for this beauty, my problem is solved."

Paints prove to be purely a chemical proposition. They contain some oil similar to linseed oil, a filler that covers a lot of space, and a drying agent. To give color, a mineral compound is added. This combination gives an opaque substance that covers a surface with an even pigment. Lately a clever chemist conceived the idea of grinding the coloring matter to a very fine powder and adding this material to the base. The small color specks cling to the larger particles of the base and give an even color while the base is so thoroughly impregnated with color that much less of it is necessary. In this way we obtain a better product more cheaply. Chemistry has also given high-grade varnishes, shellacs, and more recently pyroxylin lacquers secured from nitro-cellulose.

Dyes, another source of color in the home, have a rather romantic history. Colored clothing has always appealed to man but the ancients had only a few dull, drab grays, blues, and black. True, there was Tyre, blessed with the murex, a tiny snail-like fish, which yielded a substance from which the famous Tyrian purple was made. But each murex gave only an infinitesimal amount. Hordes of workers were needed to pry open a few thousand of them to dye an emperor's gown. You certainly did have to be "born to the purple" in olden times.

Do you know where we secure our dyes? You will never guess; it is from coal tar. When I first read that I wondered how on earth a chemist ever thought of getting beautiful colors from such a sticky mess. But it seems that the discovery was partially accidental. Perkins was looking for quinine and stumbled upon the dye mauve. It sounds quite simple,

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "Chemistry in Relation to the Home."

does it not? But there is a story of continued effort behind it. However, the color mauve was very popular for a time, and was used everywhere. From this beginning other chemists worked out means of obtaining other shades. The basis of our dyes is aniline, a distillation product of coal tar, which while not a dye itself is a producer of many colors. Vivid colors, delicate tints, all have been reduced alike to a chemical formula. In fact the chemist is able to diagram their several structures. The day has passed when chemists mixed haphazardly several evil-smelling chemicals, prayed they would not explode and sometimes stumbled upon something valuable. The process now is quite mathematical, precise, respectable.

The application of dyes opens another field of interest. Some beautiful dyes prove fugitive when exposed to light. This fact must be considered when the dye is applied. Such a color might be useful for an evening gown but would scarcely be in demand for a dress to be worn playing tennis. Dyes for washable fabrics must be able to withstand repeated launderings. Imagine the havoc one garment could cause if it were to become flighty in a tubful of clothes! Then some dyes will readily tint animal fabrics, such as wool or silk, but balk when they are asked to give their services to any others. A certain class of dyes may be applied directly to a fabric, and in consequence present a comparatively easy proposition. Others have to be coaxed into the fabric by means of a go-between called a mordant. The cloth is first immersed in this mordant, which makes it infinitely appealing to the dye which in turn rushes to combine with it. Different mordants allow many different colors from the same dye. All in all, the industry has its complications.

It is interesting to know that recently a chemist with not too great a reverence for the sacrosanct past prepared some dye from the murex and compared it with the modern dye of the same chemical formula. The coal-tar dye was far superior. Although as yet no poet has been stirred to the soul with the romance of a modern dye works as they were with the ancient process, this one alone of the 1001 dyes we own is worthier of the Muse's consideration.

Graceful draperies, springy rugs, plump silk cushions, utilitarian blankets, look over all of them. They clothe a home in very truth. Fabrics dear, fabrics flimsy, all are found in a typical list of household furnishings. In this scheme of things our old friend chemistry snugly fits.

Let us first consider cotton, used for clothing in old India long ago, and gradually improved in texture through the centuries. A few years ago it had apparently reached the apex of improvement. It was fairly serviceable but it lacked luster, that appealing glimmer that fine-textured cloths may give. A clever chemist, Mercer (you have heard of mercerized cotton I'm sure), discovered the fact that if cotton is immersed under tension in

caustic soda, the resulting product has amazing new qualities. Among them may be numbered added tensile strength and that shine that appeals to the eye. For some time, therefore, this new fabric vied with silk for decorative purposes.

As sheep and goats, no matter of how aristocratic a breed, are not addicted to baths, the wool taken from them requires cleaning before it can be made into cloth. This is no longer a manual process. Wool is chemically treated to remove grease and grime. Burrs are "carbonized" by the action of aluminum sulfate or sulfuric acid; the wool is dried; the particles may be beaten out as dust.

Natural silk, from her legendary beginning in the hands of a Chinese empress, has been an aristocrat. Her attitude has been one of rigid aloofness from the more sensible fibers. Emperors and kings were the only ones to whom she would give her services. Chemistry attempted to distribute silk to the average man by aiding in the degumming process, washing process, and bleaching. A study of cocoon diseases was also carried out. But the silk-worm product proved elusive when pursued by the average pocketbook.

Wily man, however, was determined to have silk and quite audaciously attempted to produce an entirely synthetic silk—a silk that would equal, they hoped, in fineness and beauty, that which the worm produced from his tiny spinnerets. Chardonnet was the first to win success and the industry was thus established and later developed. Cellulose in the form of wood pulp or cotton is the raw material. This is chemically treated and forced through tiny holes, spinnerets, into a setting bath. There are variations in the chemicals used but the same general procedure is followed to give a fiber of fine quality.

At first the general public was inclined to look askance at such an unusual fabric. The repute of a substance which was introduced as "artificial" silk was believed to be shady. But after the synthetic youngster became less lustrous and more rustly we quickly became educated to the idea. Such remarkable things may be done with this cellulose product! A pattern may be printed on the thread-like form and a marvelous shading design obtained. We may combine the silk with other fabrics in a single shining thread or in an intricate weave, while embroidered on a dull background the silk gives an exquisite appearance.

Our homes are silk-clothed now. We are accustomed to our soft-toned lamp shades, to fluffy, ruffled cushions, to the tremulous gleam of silken table scarfs, to the shimmering grace of window hangings. Most of the silk is the chemist's favorite child, his proud synthetic exhibit. But he should be a bit cocky over it, inasmuch as there was something humiliating in dependence on a worm for ideas of silk-making.

Home lighting is another chemical achievement. The electric bulb

alone has a long history. It works on the principle that when certain substances are treated to an electric current they show such active resistance that they positively glow. An enterprising scientist realized that if this process were carried out where no oxygen could come in contact with it, the metal would be unaffected. The first filament, used by Edison, was carbonized paper enclosed in a glass bulb deprived of air. This filament was not long-lived, however, and chemists searched for ways of improving it. The metal tungsten was very satisfactory except that it did not melt at a reasonable temperature and was consequently very difficult to work with, but eventually a way was found to draw the metal into a very fine wire. It is far superior to any previous product because it gives added brilliance with less electricity. Inert gases such as neon and argon and the almost inert nitrogen have been used in bulbs and this addition, too, gives a finer product.

Lighting fixtures play an important part in home decoration. We picture an attractive living room as containing side brackets or hanging fixtures, a reading lamp by a comfortable chair, a shaded table lamp or two, all giving a pervading sense of cheerfulness. Some far-seeing individuals have surmised that in years to come we will depend entirely on lighting for decoration. We will supply variety to a neutral gray background by use of different surfaces for the reflection of colored light. There is a world of difference between the shine of light on lusterless paint, on satin, on rich mahogany, and sparkling glass.

Glass is not essentially a modern proposition. The old Egyptians had beautiful glassware, but they could not do with glass whatever they wished. Most of their glass was of the quality of our green bottle glass. Why, eventhe Venetians who were able to make graceful decorative glass objects could not make a crystal clear window pane. But we have the art fairly well mastered. Chemists consider glass as a whole to be a mixture of silicates. It is prepared by heating a mixture in a tank furnace kept in continual operation. Brittleness is guarded against by gradual heating and subsequent slow cooling over a period of days while color is governed by the addition or removal of certain minerals or mineral compounds. Cobalt imparts a characteristic blue color; silver gives yellow; gold gives the warm-toned ruby glass. Other metals, less well known, give further variety. Glass may be blown into shape mechanically and a very even quality obtained since the rate of pulling and pressure of air is constant. Some glass is pressed; some rolled on a flat table; some pulled into sheets. As the result of the chemist's hand in glass-making we have for our homes colorful, tall black candlesticks, vivid orange, or muted orchid bowls, crystal-clear goblets, imitation gems, graceful glass flowers.

Radio is present in its better or its more annoying form in almost every American home. Physicists may claim its principle; but chemists brought

it to the people. Radio transmits waves of such high frequency that they are imperceptible to the human ear. In the receiving sets are amplifiers and detectors which aid the process of attuning the waves to those within our range. Many of these parts were originally discovered by chemists and are the products of chemical action. Enameled wire, insulating varnishes, and many accessories are chemical contributions. Even the beautiful cabinets which enclose the home radios have been treated chemically at more than one stage of their existence. Chemistry has made radio parts cheap enough for all to enjoy the use of them.

Radio is the means of splendid cultural influence. It may be abused (and some programs are pathetic) but as a means of cultural development it is splendid. Housewives may learn of correct diets, textiles, interior decoration. You may sit at your fireside and hear famous men and learned men. Some radio lectures are as beneficial as good books. Radio is a means of spreading appreciation of science, art, and music. Not long ago a series of concerts was given for children and classics were interpreted and explained for them with the hope that understanding would lead to appreciation. It is also interesting to know that a survey taken of masters of music most popular with radio "fans" gave Beethoven a majority of votes. Radio increases our culture and since chemistry is largely responsible for our having radio we may fittingly lay its beneficial influence as a tribute before chemistry.

Since we wear synthetic clothes, beautify our homes with chemical products, acquire an appreciation of beauty through its cultural influence, we may conclude that the influence of chemistry is inescapable. But a long story of hardship, hunger, and disheartening lack of appreciation lies behind the simple statement, "Chemistry is responsible for it." Chemistry has come from the persevering efforts of chemists; their knowledge was not acquired intuitively. Remember this, ye embryo students, when next some knotty formula tempts you to hurl your book viciously at the opposite wall or when some involved theory breeds within your soul the desire to consign all chemists to the briny deep.

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EXPERIMENT TO SHOW THE REMOVAL OF IONS IN DOUBLE DECOMPOSITION*

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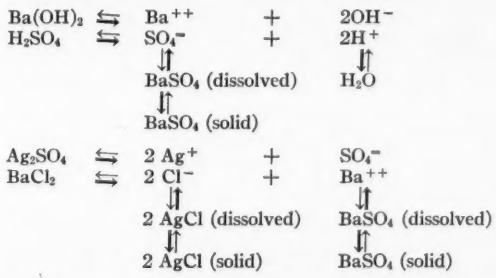
The removal of ions from solution in neutralization, and in double decomposition in which a precipitate is formed, may be clearly shown in the following very simple demonstration. Into an ordinary conductivity cell in which the decomposition of the electrolyte is indicated by the glowing of an electric lamp, introduce a solution of barium hydroxide and a few drops of phenolphthalein solution. Close the switch and show the presence of a large number of ions by the bright glowing of the lamp. Add very dilute sulfuric acid (1:100) slowly with stirring, the lamp gradually dimming until it finally ceases to glow at the same instant that the pink coloration disappears, indicating the complete removal of ions. The experiment may be repeated with a saturated solution of silver sulfate and a dilute solution of barium chloride, without the phenolphthalein, of course.

This demonstration has proved useful in elementary and general chemistry classes, and has been found especially effective when used to accompany a blackboard formulation of the ionic equilibria involved, as follows:


Ba(OH)2 ⇆ Ba++ + 2OH−
H2SO4 ⇆ SO4= + 2H+
BaSO4 (dissolved) H2O
BaSO4 (solid)
Ag2SO4 ⇆ 2 Ag+ + SO4=
BaCl2 ⇆ 2 Cl− + Ba++
2 AgCl (dissolved) BaSO4 (dissolved)
2 AgCl (solid) BaSO4 (solid)

The absence of complicated apparatus and ease in interpreting results serve to make this more effective than elaborate demonstrations in which electrical instruments and other pieces of delicate apparatus are used.

* Compare with F. F. Heyroth, "Lecture Table Demonstration of the Nature of Concentrated Sulfuric Acid," THIS JOURNAL, 3, 1321–2 (Nov., 1926).

THE RELATION OF CHEMISTRY TO THE REFINING OF OIL*

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Those cognizant of the forces about us know that to science and industry, hand-in-hand, do we owe the material comforts of the twentieth century. All about us are marvels which the mind of man has devised, marvels which would have strained our credulity twenty-five years ago—the automobile, the ocean liner, the airship, the deluxe apartment, the sky-scraper. Where shall we begin in an effort to picture the science-industry combination which has been so effective? What industry is so superlative an example of the coördination of science and industry, or more typifies our ultra-modern civilization than the petroleum industry? Let us survey in conjunction, then, the nucleus of this ramified colossus—the refinery—and the science with which it is so closely associated—chemistry.

The relation of chemistry to petroleum will be found in answer to the question, "Why is chemistry concerned with the refining of petroleum; how has chemistry helped the refining industry to attain its present significance?"

Chemistry Inherently Concerned with Oil Refining

Chemistry is the science which studies the composition of substances, their properties, and their transformations. It may therefore be applied profitably to the utilization and processing of any crude material. A realization of this fact has removed the stigma of stagnancy from many an industry. A hundred years ago the iron and steel industry was scarcely more than an obscure art. Today, having allied itself with metallurgical chemistry, it has grown to stupendous proportions. Similarly, after their inception eighty years ago by the chemist, Young, the refining processes threatened to sink into a condition of rutted procedure. But as perplexing problems were encountered time and again, which only chemistry could solve—and did solve, the dependence of a flourishing refining industry upon chemistry became greater and more apparent, and the petroleum industry renounced its self-sufficiency to embrace like a contrite child this fundamental science of matter.

History of Refining a Romance

As to how chemistry has influenced the metamorphosis of this gigantic industry—its history is a romance replete with pages which sing the achievements of chemists. Some of these pages shall be delved into.

The "Skunk" Oils and the Frasch Process

An incident which aptly illustrates the general application of chemistry to the petroleum industry is that of the "skunk" oils of the Petrolia, Canada, and Lima, Ohio, fields. The wells were prolific producers, but the oils were found to be saturated with sulfur compounds of extremely objection-

* First prize-winning college essay, 1929–30. This is one of the five specific titles prescribed under the general topic, "The Relation of Chemistry to the Development of an Industry or a Resource of the United States."

able odor. What was worse, in transportation many things in proximity with the oil were permanently drenched with the disgusting stench of the "skunk" oil. No process known could satisfactorily be employed to deodorize the crude oil; abandonment of the wells became imminent, since few indeed were the refiners brave enough to risk offense of the public nostrils. Shortly afterward, however, Herman Frasch developed his copper oxide process for sweetening the oil. The crude petroleum was agitated with the oxide, whereupon most of the sulfur was extracted in the form of a precipitate of copper sulfide. The sulfide was then calcined to recover the copper oxide. The sweetened oil compared favorably with the best of the low sulfur crudes, and yielded products whose quality paid everlasting tribute to Dr. Frasch and the science of chemistry.

Automobile Makes Waste Gasoline Valuable

Crude petroleum is a mixture made up almost entirely of organic compounds known as hydrocarbons. By fractional distillation it may be divided into fractions of varying volatility, each of which possesses its own commercial utility. Previous to the advent of the internal combustion engine in the early part of the twentieth century, it had been the attempt of refiners to keep the quantity of lighter (gasoline) distillate at a minimum. This product had been less than worthless; no possible use had been found for this highly inflammable material, and most refiners resorted to the wasteful expedient of burning it in the open field. But with the development of the automobile, gasoline became the most important and desired of petroleum fractions.

Cracking Inaugurated

Soon the demand for gasoline threatened to exceed the supply, while all efforts to "stretch" the output were inevitably accompanied by a lowering in the quality of the commercial commodity and an excessive production of the undesirable heavy fuel oil. In 1912, when the situation was most acute, the concentrated efforts of research workers effected a solution by inaugurating the system of cracking—or decomposing heavy petroleum fractions into lighter constituents.

Cracking a Chemical Problem

The decompositions of the heavy molecules of petroleum are reactions of the "reversible" type. Also, it was found that they were accompanied by an absorption of heat and usually a change in volume if gaseous compounds were involved. Therefore the search for the best conditions of cracking cheap fuel oil or gas oil fell naturally within the domain of the physical and thermal chemist. The complexity of the problem, however, is illustrated by noting a few of the possibilities in the breaking up of dodecane, a characteristic compound of the illuminating oil (kerosene) fraction:

$$2C_{12}H_{26} = CH_4 + C_{23}H_{48} - 500 \text{ cal.}$$
$$C_{12}H_{26} = C_2H_2 + 2C_5H_{12} - 47{,}000 \text{ cal.}$$

$$C_{12}H_{26} = 6C_2H_2 + 7H_2 - 381{,}000 \text{ cal.}$$
$$3C_2H_2 = C_6H_6 + 137{,}700 \text{ cal.}$$

But chemistry, given the hope of success, clung to the task with indomitable tenacity.

Temperature, Pressure, Time Factors Varied by Experimenters

From Le Chatelier's law—which states that if a system in equilibrium be subjected to a stress (heat, pressure, etc.), the state of the system will tend to alter to relieve the strain—it is seen that temperature, pressure, and also time are factors which must be closely controlled if the desired products are to be secured. In the first types of cracking stills, these conditions were invariably such that besides the gasoline and light-oil distillate, coke, and uncondensible gases were formed in undesirable quantities. The danger incurred from coke formation soon manifested itself in boiler explosions and refinery fires. Extensive experiments varying these factors revealed to chemists the fact that the reactions might be halted before a great proportion of the troublous materials were secured. The stock, in that case, would then provide a reduced amount of gasoline, but less fixed gas and a certain amount of fuel oil which could be drawn off carrying most of the free carbon in suspension. Chemical engineers further abated the coke nuisance by so designing the apparatus that the cracking stock was not decomposed until it entered a "reaction" chamber, where any coke which was deposited was removed without danger or difficulty.

Cracked Gasoline as an Anti-Knock

Relevantly, the development of the automobile has caused chemists to investigate fuels with the intent of improving their operating qualities. One of the most objectionable effects of some gasolines is the familiar "knocking." How many of us have not been irritated by the "bang-bang" of our pistons as we drive at a merry clip over the highway? Theories for this occurrence are many, but it is generally conceded that slower burning fuels produce less "knock." Chemistry would lead one to expect that the cyclic and unsaturated compounds which contain more of the slow burning element carbon should have a lesser tendency to knock—and such is the case. Of the hydrocarbons, the variety known as aromatics and naphthenes are the best in anti-knock quality, while the paraffins are the poorest. Cracked gasoline, which is rich in these aromatics, naphthenes, and unsaturated hydrocarbons, has found a fortunate use as a diluent of the straight-run "knocking" gasoline.

The Vapor-Phase Process

A cracking process which has been especially designed to yield a highly anti-knock distillate is the "vapor-phase" process. The temperature and pressure are so maintained that the decomposition reactions occur in an expansion chamber where

the previously heated oil gasifies. Its one defect is in the large quantities of fixed gas formed.

The Aluminum Chloride Cracking Process

That the efficiency of the various cracking processes in use today is far from satisfactory may be surmised from the number of patents being conferred yearly, and the interest in contemporary research. A striking example of what the science of chemistry offers those engaged in investigation is found in the recent perfection of the process for catalytically cracking heavy oils by means of aluminum chloride. About 1915, Dr. A. M. McAfee of the Gulf Refining Company found that a very good grade of gasoline might be obtained by heating the cracking stock in intimate contact with anhydrous aluminum chloride. The process was favorably received, but at first proved unfeasible commercially since this chemical sold at $1.50 per pound and could not be profitably recovered after use.

Dr. McAfee, nothing daunted, and exhibiting that mettlesome spirit so appropriately dubbed "scientific," undertook the discovery of a method for reducing the cost of his catalyst. After expending four and a half million dollars in four years of painstaking, exhaustive work, disappointment, and development his dream materialized into a practicality. Briquets of bauxite and bitumen are roasted; then they are heated to about 1600°F. and exposed to the action of gaseous chlorine. Sublimated aluminum chloride is obtained which condenses as a powder. The total cost of a pound is actually less than five cents; today the Gulf Refining Co. is operating its unique cracking unit economically and successfully.

What the Cracking Processes Have Meant

The significance of the cracking processes becomes apparent when we reflect that thirty-two per cent of the gasoline which runs our indispensable automobiles is cracked gasoline. Moreover, in every instance, the principles of general and physical chemistry have guided the efforts of investigators.

Purification of Oil With Sulfuric Acid

Few petroleum products are ready for commercial use when they are first distilled. Most must undergo treatment for the removal of injurious and foreign substances. In this treatment, chemistry plays the prime part. In 1855, Professor Silliman suggested a process which is still essentially the one used most commonly today. Light oils, and to a lesser extent, lubricating oils, are agitated with concentrated sulfuric acid, which reacts with the substances producing the colors, odors, and resins associated with inferior grades of products. The precipitate, or sludge, formed absorbs at the same time undesirable sulfur derivatives of organic compounds. The residual oil is washed with alkali and then with water to remove all traces of free reagent.

Chemists Investigate New Reagents

Chemists have long, however, been unsatisfied with the results of this orthodox procedure. In highly sulfurous oils, if increased amounts of acid were used to sweeten it, some of the oil would be lost in the sludge. Therefore, to supplement the acid treatment, lead plumbite (lead oxide dissolved in caustic soda) has been recommended as an auxiliary reagent. The sulfur content will be removed as insoluble lead sulfide. Also prominent among the recently developed purifying agents are alkaline hypochlorites. The oxidizing property of the hypochlorite is utilized to transform injurious substances to less deleterious ones.

The Edeleanu Process

The treatment of kerosene or of gasoline often differs. In motor fuels aromatic, cyclic, and unsaturated compounds are highly desirable because of their anti-knock properties, while in kerosene these same compounds will cause soot formation when burned in the ordinary type of lamps. The customary acid treatment is not sufficient to remove enough of these cyclic and unsaturated compounds from kerosenes—such as some Californian and Roumanian distillates—which contain a preponderance of these substances. Dr. Edeleanu, investigating Roumanian oils, successfully separated these compounds by employing the solvent properties of liquid sulfur dioxide. The kerosene thus treated was always clean in its combustion, and the compounds dissolved by the sulfur dioxide could be recovered as by-products.

Edeleanu Process Applied to Gasoline

The Edeleanu process is finding application in gasoline purification at present, since the liquid sulfur dioxide will remove most of the obnoxious sulfur compounds, and since the anti-knock compounds dissolved may be returned in any desired amount to a treated gasoline.

Treating of Cracked Gasoline Inefficient

As a matter of fact, no process for commercially purifying cracked gasoline has yet been invented which is not accompanied, to a greater or lesser extent, by the loss of some of the anti-knock unsaturated and cyclic compounds. Filtration of the cracked gasoline vapors has been employed with a certain measure of success, but the refining industry looks forward expectantly to the intense work of their chemical researchers for more effective methods.

Corrosion of Stills a Serious Problem

Lately chemists have directed their attention to the reduction of the corrosion hazard. Acidic constituents, particularly sulfur acids, weaken stills, not only endangering the lives of the workers, but necessitating replacement expenses. Notably in cracking stills, where the conditions of temperature and pressure are especially conducive to the formation of the products of corrosion, means of prevention must be taken. Often the acids are neutralized by lime or caustic soda before the stock is charged.

The one serious defect of this procedure is the devaluation of the by-product sludge, which could otherwise be profitably used.

Alloy Steels Find Useful Application

Corrosive resistant materials are also being used where the destructive action of the sulfurous compounds are most manifest. Alloy steels of various compositions have been found effective. Chrome steels received wide application, but it was found that welding marred the homogeneity of that material and that the steel had a tendency to become brittle at high temperatures. The research department of the Krupp works in Germany has recently developed a steel containing about eighteen per cent of chromium and eight per cent of nickel, which represents a decided improvement in qualities. Not only are the defects of the simple chrome steels eliminated, but the corrosion-resistant properties, the durability, and the workability are increased.

Trend of Chemistry to Be Dwelt Upon

No survey of the chemistry of petroleum refining is complete without lingering briefly upon its future possibilities.

Chemists Neglect By-Products

The basic products of the petroleum industry, such as the fuels, lubricants, waxes, and vaseline, are so much in demand that chemists have paid little attention heretofore to the utilization of by-products or the synthesis of organic compounds from petroleum hydrocarbons.

Valuable By-Products Extracted From Sludges

The by-products that are most indicative of the potentialities of similar materials, which the chemist has not yet deemed wise to isolate, are the naphthenates, sulfonates, and their respective acids—obtained from the acid and alkali sludges of the treating processes. The chemist has found use for naphthenates in soap and wood preservative manufacture; sulfonic acids are widely used in soap industries.

Petroleum May Sometime Rival Coal Tar

That petroleum compounds are a fertile source of valuable organic derivatives is not questioned. Already ethyl alcohol has been synthesized from petroleum ethylene; rubber has been derived from butadiene, which had been isolated from the products of the cracking still; formaldehyde has been made by the oxidation of ethane; and explosives have been synthesized from the aromatics of cracked and natural oils. As economic conditions become propitious, the chemical utilization of the products and by-products of the petroleum industry will undoubtedly assume an importance and direction analogous to that of the remarkable coal-tar industry.

Chemistry the Pathfinder

Certainly, whether the development of the petroleum industry flows in the expected channels, or is checked by the much-feared shortage in the crude oil supply, the

petroleum industry in general, and the refining industry in particular, look toward chemistry and its students for guidance and achievement.

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How Students Use Their Leisure Time. It is now definitely accepted that the modern high school should be interested in the problem of leisure time. Recently a questionnaire regarding the spending of leisure time was filled out by a large number of Flathead students. Here are some of the most interesting results:

1. All the underclassmen who filled out the questionnaire and all but 6 per cent of the upperclassmen do some reading during their leisure time. The average number of hours spent at this is 7.3 a week.

2. Forty-three per cent of the underclassmen and 55 per cent of the upperclassmen do something in the way of music performance. Five and four-tenths hours per week are thus spent on the average.

3. All but about 10 per cent of the students spend time listening to music. Ten and three-tenths hours are spent this way—the most time that is spent on any leisure-time activity.

4. Seventy per cent of the underclassmen and 83 per cent of the upper classmen attend shows with more or less regularity; the typical one of these attends 1.5 times during the week.

5. Eighty-two per cent and 72 per cent participate in physical activities—sports of various kinds. The number of hours spent this way is five. Please notice the decrease in percentages. Perhaps this is due partly to lack of gymnasium facilities.

6. Sixty-three per cent and 75 per cent participate in games such as cards, pool, and billiards. The average is three hours weekly.

7. Forty-nine per cent and 68 per cent dance; 4.2 hours weekly are spent this way.

8. Forty-nine per cent and 34 per cent read the *American Magazine;* 8 per cent and 12 per cent the "high-class magazines" (such as *Atlantic, Harper's,* etc.); 28 per cent and 13 per cent the "cheap trash." Notice the favorable trends. The *American Magazine* is undoubtedly the favorite with all classes.

9. For the underclassmen, outdoor sports are the favorite recreation, with reading a poor second. With the upperclassmen, reading is by all odds the favorite, with outdoor sports a poor second. Dancing is ranked fourth by the underclassmen and sixth by the upperclassmen. Shows are not especially popular with either group.—*The Flathead Messenger,* Kalispell, Mont.

THE VALUE OF ORGANIC QUALITATIVE ANALYSIS AS A METHOD OF INSTRUCTION IN ORGANIC CHEMISTRY*

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The educational value of the study of inorganic qualitative analysis is now so well recognized as to require no reiteration. This is attested by the multiplicity of texts now available, by the general inclusion of the subject in the chemical curricula of all the higher scientific institutions of learning, and by the rise of professional symposia on the methods and technic of teaching the subject.[1] In the organic field, however, there seems to have been considerable delay in recognizing that a similar study of the fundamental principles of qualitative organic analysis possesses even greater educational advantages.

By the term organic qualitative analysis is here meant the identification of organic compounds, both in the pure state and when present as the components of mixtures. Viewed from this angle the number of colleges offering courses of this kind is regrettably small. Of course the qualitative detection of the elements commonly occurring in organic compounds is a part of every elementary organic laboratory scheme of instruction, and laboratory practice in the classical methods or organic combustion is also included in many of the longer courses. The identification of an organic compound by means of a comparison of its properties and reactions with those previously on record, however, is a process whose thoughtful execution furnishes peculiarly valuable training both in theoretical and practical organic chemistry but whose practice has not yet been widely apprehended.

It should not be understood from this general claim, however, that an alternative to the conventional method of teaching organic chemistry is thus proposed. On the contrary, a fundamental prerequisite for such a course in the identification of organic compounds is a previous acquaintance with the fundamental theories, typical classes of compounds, and characteristic group reactions of simple organic substances. This introduction is best acquired by a thorough systematic study of characteristic materials via the lecture and recitation method. Moreover, it is highly desirable that some training in the fundamental unit operations of laboratory procedure should have been obtained prior to their use from the analytical viewpoint and this preparation is conveniently afforded by the synthetic type of laboratory instruction. These prerequisites are well recognized in the inorganic analytical field and are equally essential in the present connection.

* Presented at the Colloquium on the Teaching of Organic Chemistry, Third Organic Symposium, Princeton, N. J., December 31, 1929.

[1] Symposium on the Teaching of Analytical Chemistry held by the Division of Chemical Education at the 75th Meeting of the American Chemical Society, St. Louis, Mo., April 17–18, 1928. THIS JOURNAL, **5**, 937–78 (Aug., 1928).

Granted the necessity of a preliminary training in the general theory and practice of organic chemistry, however, the study of organic qualitative analysis may well be substituted for a long program of simple synthetic preparations. This comment should in no wise be construed as deprecating the practice in advanced synthetic methods and technic, such as high-vacuum distillation, hot-tube reactions, manipulation in absence of air, etc., but merely as a protest against excessively long programs of simple preparations. At Technology we are frequently confronted by students transferring from other colleges who wish to be excused from organic laboratory work on the basis of an equivalent or larger number of hours spent on the subject elsewhere. Examination of the nature of the work performed all too often discloses that it consisted exclusively of a great number of synthetic preparations, sometimes accompanied by a few test-tube experiments on the products obtained. In extreme cases such a program has included fifty such preparations selected with no regard as to whether the unit procedures of elementary laboratory technic were adequately represented or not. It is still exceedingly unusual to find laboratory courses which include any systematic instruction in the methods of identification of organic substances.

The Educational Merits of the Study of Organic Qualitative Analysis

In supporting the thesis that a study of organic qualitative analysis is of unique advantage to the student there are six aspects which may be considered here. First of all, the student becomes acquainted with many more compounds than would otherwise be the case and learns to generalize and systematize his knowledge of their behavior. Where time is available this aspect of the work may be enriched by instruction in organic nomenclature and in the classification and use of Beilstein's *Handbuch*. In the second place as the student thus widens his circle of chemical acquaintance, he is invariably impressed with the influence of environment on the behavior of atoms and groups in the various compounds. For example, his discovery that the aromatically combined halogen of *o*-chlornitrobenzene may be hydrolyzed with aqueous alkalies usually comes to the student as a distinct surprise despite the fact that this has repeatedly been mentioned in the lecture work.

As he pursues his study of the identification of organic compounds, the student learns, in the third place, many useful variations of the simple methods of typical processes. He finds, for example, that although the simplest theoretical method of acetylation is to employ acetyl chloride, the most feasible practical method may appear quite different and employ acetic anhydride, or acetic anhydride in pyridine solution, or acetic anhydride together with sodium acetate. Moreover, despite the title of organic "qualitative" analysis, a properly conducted course will, in the fourth

place, impress upon the student that very often the numerical measurement of some physical or chemical characteristic of the compound is a powerful tool in its identification. Thus the student comes to have a new respect for the practical utility of the determination of melting points, boiling points, neutralization equivalents, saponification equivalents, densities, refractive indexes, etc.

Furthermore not the least important advantage of the study of organic qualitative analysis is its emphasis on the use of small quantities of materials. It generally amazes the student to discover that a derivative may often be more conveniently prepared from two drops of a liquid than from 2 cc., but he is quick to appreciate its obvious economy of material and time. This aspect of the subject is strictly in accord with the modern stress of micro-methods and affords one means of stimulating the use of micro- and semi-micromanipulation. Incidentally, due to the economy of time brought about by their use, the field of experience acquired by the student is much greater than where the same amount of time is spent on preparative work.

Finally, the most valuable contribution of the study of organic qualitative analysis to student training is the different viewpoint which it leads him to acquire. No longer is he able blindly to follow in the "cook-book" style the directions given, but is required to devise a mode of procedure suitable to the requirements of each particular problem. The very nature of the work causes the student to ask himself questions constantly and this is the first step in constructive thinking for himself. The assignment then becomes a kind of chemical contest in which the student acts first as a detective to ferret out the facts and later as a lawyer, bringing up in logical sequence not only the evidence available to support his identification but also such facts as will refute possible alternatives. Hundreds of Technology chemical and chemical engineering graduates assure us that the training afforded by their study of the methods of identification of organic compounds has not only been the most interesting part of their organic experience but has been of the most practical value. It is significant to note that the value of the subject is questioned only by persons who have had no actual experience with it.

The Administrative Merits of the Study of Organic Qualitative Analysis

In addition to the educational merits of the study of organic qualitative analysis, to some of which your attention has thus been directed, there are certain features of the subject which possess administrative advantage. Some of these will be less relevant to schools where classes are small and where practically individual attention can be given, but all have general interest. Their discussion will perhaps serve to emphasize the fact that the subject can be taught to large groups as well as to small ones.

The first administrative advantage is that the work is well adapted for use with short laboratory periods and yet retains the continuity of interest throughout each analysis. Experience shows that this kind of work possesses all the fascination of the hunt and that groups of students will discuss almost tirelessly among themselves ways and means to effect some peculiarly refractory identification. In the second place, since each student has a different assignment of unknowns the resulting variety of problems which come up for discussion in the classroom exercise is profoundly stimulating both to class and instructor. While here the very variety is an advantage, a corresponding degree of diversity in discussion of synthetic procedure usually mars the unity of presentation. At this particular time we are conducting an analytical course with a class of 74 students using 261 different simple unknowns. Since each student assignment includes the identification of six of these, it is plain that some unknowns must be given out more than once but there is no harm in this. Furthermore, from a stock of 76 mixtures, each of which contains from two to five components, two are assigned to each student for separation and identification of each part. Since great care is taken to see that each assigned desk has a thoroughly representative selection of the several types of organic substances, we have never suffered from lack of variety.

In the third place, despite the number of individual materials which may thus be involved the cost of administration of a qualitative course properly coördinated with the preceding synthetic studies need not be excessive. For unknowns it is desirable to employ the more common substances and the cost of these can be kept low. Furthermore, it may often be arranged to use as student preparations those materials which are to be extensively employed as reagents in the analytical work. Thus phenylhydrazine, 3,5-dinitrobenzoic acid, benzenesulfonyl chloride, methyl iodide, nitromethane, semicarbazide, and many others can be prepared in the synthetic work, purified by an assistant, and used in the analytical procedures. The possible extension of such a program to the preparation of the unknowns themselves is obvious.

Finally, an important administrative advantage of organic qualitative analysis is the elimination of the tendency toward fraudulent work. The student in this course has no opportunity to fortify his yield of preparation from the drug store and he is hardly likely to go to the expense of having his analysis made elsewhere. Since for the most part the unknowns assigned are different and care is taken that necessary duplications are assigned to widely different locations, there is but slight chance to copy results from other students. Since each identification must be accompanied by a small sample of the derivative required in each instance, any tendency toward indiscriminate and unintelligent guessing may quickly

be curbed, and an additional check on the authenticity of the analysis thus afforded.

In the light of the educational and administrative merits of the study of organic qualitative analysis, only a few of which have been discussed in the time here available, it must confidently be expected that the next decade will witness a profound growth in its appreciation and development.

Brauner, Investigator of Rare Earths, Honored by Czechoslovakia. Prof. Bohuslav Brauner, the eminent Czechoslovak man of science, distinguished for his investigations in the chemistry of the rare earth elements, has just attained the jubilee of his "promotion" as doctor of philosophy at the Charles University of Prague. This event was celebrated according to the traditions of the University by a solemn renewal of his diploma on February 28th. Prof. Brauner has also recently been made an honorary member of the Polish Chemical Society, thus adding to the long list of foreign distinctions which have been conferred upon him in recognition of his researches in inorganic and analytical chemistry. Among his more important discoveries mention may be made of his independent isolation of fluorine, carried out at Manchester in the early 'eighties, the recognition of the complexity of didymium and its fractionation into praseodymium, neodymium, and samarium. He was among the first to realize the full significance of Mendeléeff's periodic classification of the elements and in support of it he undertook the redetermination of the atomic weights of many rare earth and other metals. He had deduced, so early as 1877, that beryllium must be bivalent and therefore has the atomic weight 9, thus bringing it into line with Mendeléeff's scheme. Prof. Brauner's interest in the classification of the elements brought him into close contact with the Russian savant, and their intimate friendship only terminated on Mendeléeff's death. Prof. Brauner shares his countrymen's talent for languages, and writes with equal facility in six or seven European languages. Many of his original researches have appeared in English journals, including *Nature*. Mention must also be made of his influence in Central Europe, for he has established, at the Chemical Institute of the Charles University of Prague, a school of research which maintains the high traditions associated with his work.—*Nature* (London)

Xylose from Seed Waste. Xylose, a sugar so rare that it has heretofore been a laboratory curiosity at $100 a pound, can now be turned out cheaply at a few cents a pound, requiring no raw material other than waste cottonseed hull bran, water, and sulfuric acid. At the meeting of the chemistry section of the American Association for the Advancement of Science, Warren E. Emley, of the U. S. Bureau of Standards, described the process by which seed waste is changed into sugar. Xylose is different from its nearest neighbors in the sugar world, the hexoses or glucose type of sugars, in that it contains five carbon atoms to the molecule instead of six. Because it has always been so rare and expensive, it has never been possible to perform any extensive experiments with it, and consequently it has no known uses. But the experimental plant at Anniston, Alabama, can turn out a hundred pounds a day, and when larger units are built they will have an annual production of about a million tons of cottonseed hull bran to work on. So that if xylose has any uses it should not take long now to discover them. Mr. Emley suggested that it might be used directly in food products, or possibly industrially as a raw material for alcohol, acids, and other chemicals.—*Science*

QUALITATIVE ORGANIC ANALYSIS IN THE TRAINING OF THE ORGANIC CHEMIST*

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The student of organic chemistry must undergo a rather abrupt transition in his training as he progresses from the almost purely descriptive lectures and precise laboratory procedures of his beginning organic chemistry courses to research. The latter involves considerable mental initiative in intelligently planning the mode of attack on a problem and ingenuity in adapting procedures given in the literature, which are often inadequately described, to the synthesis of the compound desired. One of the best means of bridging this gap and developing research ability is the course in qualitative organic analysis. The purpose of the present discussion is to outline briefly the essential features of this course and to point out its value in the development of the organic chemist.

Content of the Course

Since the primary objective is to develop originality in the student, the course is based on laboratory work which the student must plan for himself. His first experiments are designed to review and emphasize certain reactions important from a laboratory standpoint. Although any of the qualitative organic analysis schemes may be used the present discussion will be based on the procedure developed by Kamm.[1] The following outline shows the topics studied and gives a brief discussion of each.

I. Solubility Study.—The student determines the solubility of known compounds in water, ether, dilute hydrochloric acid, dilute sodium hydroxide and cold concentrated sulfuric acid. The compounds used in these tests are so chosen that several examples of all the common homologous series are studied. As a result of this study, the student correlates structure and solubility and learns to classify organic compounds into seven groups.

II. Class Reactions or Homologous Tests.—The second subject studied is the action of certain common laboratory reagents on known compounds. Here the student is taught to associate the results of these tests with the functional groups. He learns not only the scope of these tests but also their limitations. Some of the common reagents whose behavior is studied are:

1. Bromine in Carbon Tetrachloride
2. Bromine Water
3. Dilute Potassium Permanganate Solution
4. Fuming Sulfuric Acid
5. Metallic Sodium
6. Acetyl Chloride
7. Benzoyl Chloride (Schotten-Bauman)

* Presented before the Colloquium on the Teaching of Organic Chemistry at the Third Symposium on Organic Chemistry, Princeton, N. J., December, 1929.

[1] O. Kamm, "Qualitative Organic Analysis," J. Wiley and Sons, New York, 1923.

8. Sodium Amalgam
9. Alcoholic Silver Nitrate
10. Benzene Sulfonyl Chloride (Hinsberg)
11. Nitrous Acid
12. Phenyl Hydrazine
13. Fehling's Solution
14. Tollen's Reagent
15. Sodium Bisulfite
16. Ferric Chloride

The student also learns to run DuClaux constants, neutral equivalents, and saponification equivalents at this time.

III. Identification of Individual Unknown Compounds.—The third step in the student's training consists in the identification of five pure unknowns. The following outline shows the general procedure for identification.

1. Determination of physical constants.
2. Qualitative analysis for the elements, N, S, P, Cl, Br, I, and metals.
3. Solubility determination.
4. Homologous tests.
5. Consultation of the literature and preparation of a list of possible compounds whose properties agree with the above data.
6. Final identification by preparation of a unique derivative; *i. e.*, conversion of the unknown into another compound by an accepted reaction which proceeds in a known way and determination of the physical constants of this derivative.
7. Presentation of a written report on the unknown which lists and tabulates the above data and indicates the proof offered that the unknown is actually the compound reported.

IV. Study of Mixtures.—The last subject on which the student works is the separation of the constituents of mixtures. After isolation of each constituent in a pure state, it is identified by the above procedure. Three types of mixtures are studied:

1. Mixtures whose components are water soluble.
2. Mixtures whose components are water insoluble.
3. Mixtures which are intermediate between Types 1 and 2.

The foregoing outline represents the major portion of the course. A series of conferences which parallel the above laboratory work are used to discuss the theoretical aspects of solubility and class reactions. The factors governing the choice of derivatives and a general discussion of the mode of attack on mixtures are also taken up during these conferences.

The last part of the course is devoted to the solution of problems. These problems present laboratory data on unknown compounds and the student deduces the structure from the experimental behavior. It is here that the student learns to coördinate data and to reason clearly and logically.

Value of the Course to the Student

As the student proceeds through the course his viewpoint of organic chemistry changes. He correlates his information and begins to connect the observed behavior of compounds with their structures. He sees a

relationship between structure and solubility, and structure and chemical behavior. In his elementary organic chemistry, compounds were studied by homologous series. Here the student studies the behavior of different homologous series with a few reagents. He sums up his knowledge of organic chemistry and arranges it in an orderly fashion in his mind.

In the second place qualitative organic analysis is not a "cook-book" course. The procedure and method of attack are provided in a very general way but the student is compelled to use his own knowledge in choosing class reactions and deducing information therefrom. He must actually think and plan the laboratory work on his individual unknowns.

The course also provides the best possible introduction to chemical literature and the practical use of the library. In order to prepare the list of possible compounds the student must not only consult the handbooks of Mulliken, Kamm and Clarke, but also Beilstein, Richter, Stelzner, and for recent work, *Chemical Abstracts*. By this use of common reference records of previous work in organic chemistry the student is brought to recognize not only the value but also the limitations of the chemical literature. In his search for suitable derivatives he finds great gaps in our knowledge and so becomes aware of the necessity for research.

The preparation of the written reports on the unknowns is of great value to the student. Here he tabulates his data and really sees that his tests have proved the structure of his compound. This written report also places the emphasis on the *proof* of the identification and not merely on the identification itself. This is a point that is emphasized over and over again in the conferences; *i. e.*, it is the proof that is worth everything. It is this factor which makes identification by the "smell and guess" method impossible. No credit is given for an identification without proof. This removes any tendency to cheat. Assigning each student different unknowns gives him a feeling of individual responsibility and pride in his identifications. The net result is the development in the student of a proper scientific attitude of mind toward investigating the unknown. The general *esprit de corps* of the students in this course surpasses that in any of the other courses.

Finally, as the result of his work in this course the laboratory technic of students is very greatly improved. The amount of the unknown supplied to the student is limited in quantity. He learns to work with small quantities and hence becomes of necessity more careful, neat, and precise in his manipulation.

From the viewpoint of both student and teacher the course is a most enjoyable one. The students enjoy the chemical detective work necessary to run down and prove "beyond a reasonable doubt" the identity of an unknown compound. The teaching of the course is a pleasure since it is a fruitful source of new ideas for research. New reagents, new re-

actions, new procedures, and new derivatives are continually suggested, while improvements in the old methods are made each time the course is taught. The deadly monotony of constant repetition is entirely missing.

Men Responsible for Development of Course

Any discussion of qualitative organic analysis would be incomplete without mentioning the men who have been primarily responsible for its development. Professor S. P. Mulliken was the pioneer in the field and his monumental volumes of "Identification of Pure Organic Compounds," the first volume of which appeared in 1905, marks the beginning of this line of work. H. T. Clarke's "Handbook of Organic Analysis" (first edition, 1911) offered an abbreviated identification of the more common organic compounds. The tables in this handbook, which has been revised and brought up to date (1926), are excellent.

At the University of Illinois this course was instituted by Dr. C. G. Derick in 1908 and elaborated and developed by Dr. Oliver Kamm (1911–15). Dr. Kamm's great contribution to systematic identification was the classification of compounds into seven groups by means of their solubilities. Since then new derivatives and procedures have been contributed with the result that the course now represents the experience of many men.

Staudinger, at Zurich, also gives a course in qualitative organic analysis which is based on volatility and solubility. His scheme was published in 1925.

Regardless of the specific procedure adopted, there is no doubt that qualitative organic analysis occupies an important place in the training of the organic chemist and assists in preparing him for research.

Production of Helium from Monazite. The industrial sources of helium have in recent years attracted a considerable amount of attention in view of the use of this gas in place of hydrogen for filling the gas containers of airships. In the United States a considerable amount of helium extracted from natural gas, the rich varieties of which contain about 1 per cent of helium, is available and in use. An alternative source of helium which is of great interest in the possible applications of the gas in the British Empire is the mineral monazite, the raw material for the production of thoria for incandescent gas mantles, which is found in large quantities in Travancore, India. In the issue of Dec. 27th of the *Journal of the Society of Chemical Industry*, Mr. R. Taylor, who has been working in the Chemical Research Laboratory at Teddington under the direction of Sir Richard Trelfall and his successor, Prof. G. T. Morgan, describes some interesting experiments on the production of helium from monazite. The mineral contains about 1 cc. of helium per gram, and thus in the working up of every 100 tons of monazite about 100,000 liters of helium are allowed to escape into the atmosphere. The gas escapes on heating, and the paper describes how it is purified by treatment with hot metallic calcium, which absorbs nitrogen and other gases. It is advantageous to remove most of the nitrogen by heating magnesium before treatment with calcium. Working drawings of the apparatus are given in the paper.—*Nature*

LECTURE EXPERIMENTS IN ORGANIC CHEMISTRY

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In presenting a new term to a class in chemistry, the teacher should always keep in mind the possibility that the students may memorize the definition recorded in the book, or that given by the lecturer, without recognizing any connection between the term and the chemical behavior to which it relates. In some cases a lecture experiment may help to make the connection clear.

In order that such a demonstration may be successful and carry the correct idea to the student, it must meet certain requirements. It goes without saying that the experiment must work. To insure this, every part of the apparatus should be carefully examined beforehand by the lecturer or the experiment run through before the class comes in. The apparatus should be simple, the reaction should be direct and rapid. Some definite relationship should be illustrated by the experiment, and special pains should be taken to explain this relationship in terms with which the students are already familiar, including the necessary equations, when possible. It is believed that demonstrations similar to the ones described below will meet these requirements.

Addition and Substitution

One difference between addition and substitution may readily be illustrated by showing that bromine reacts with some compounds without the evolution of hydrogen bromide, while with others that gas is liberated.

In a suitable flask (*A*) of 100–150 cc. capacity, place 50 cc. of a carbon tetrachloride solution of allyl alcohol containing about 10% of the latter, and close the flask with a two-hole rubber stopper. In one hole place a dropping funnel containing a quantity of 10% solution of bromine in carbon tetrachloride. In the other place a right angle bend of glass tubing, and connect this with a U-tube containing enough solution of silver nitrate to prevent the free passage of gas. Set up a second flask (*B*) with similar connections, but place in this one about 50 cc. of a 10% solution of phenol. This should be freshly prepared from pure crystals of phenol in order to obtain a colorless liquid. Now allow the bromine solution to drop slowly into each flask, when the red color will disappear promptly in each case. No precipitate will form in the U-tube connected with flask (*A*), which shows that no hydrogen bromide is evolved in the reaction taking place there. Heat is liberated, consequently air will bubble through the silver nitrate solution at the beginning of the experiment. In the U-tube connected with flask (*B*) a precipitate of silver bromide will be formed, showing that hydrogen bromide was formed in that flask. Black cardboard behind the apparatus will make the result more easily seen at a distance.

Action of Nitrous Acid on a Primary Amine

Fit a 100-cc. flask with a two-hole rubber stopper and attach to one opening a bent glass tube arranged to collect gas over water. In the other place a dropping funnel, the stem of which should extend to about the center of the bulb of the flask. In the flask place about 4 g. of ethylamine hydrochloride, 4 cc. of concentrated hydrochloric acid, and enough water to fill the flask, including the neck, to a level about 2–3 cm. below the stopper. In the dropping funnel place a solution of sodium nitrite containing 3.5 g. of the salt in 10 cc. of water. Adjust the delivery tube so as to collect gas, and in order to take care of small quantities of oxides of nitrogen that may be formed it is advisable to fill the collecting cylinder with 10% solution of sodium hydroxide. Allow the nitrite solution to enter slowly, then close the stopcock of the funnel. While the gas is being collected, arrange a condenser with a suitable receiving vessel. Test the gas with a lighted splinter. Pour one-half the liquid from the generating flask into a distilling bulb, attach to the condenser and distil 25–30 cc. Test the distillate for ethyl alcohol by means of the iodoform reaction. Write the necessary equations.

New Hardened Copper Alloys Make Razor Blades and Shears. Soft copper, that easily worked metal used extensively for electric wiring and electrical apparatus, has been made into a razor blade that holds its edge and shaves, and scissors that cut thin paper. Even the ancients had hardened or tempered copper. Razors and shears have been made in past years as curiosities, but it has remained for "us moderns" to make a copper both as hard and as useful as steel.

The two modern hard coppers, Everdur and Tempaloy, were found during searches for something else, a report to the Engineering Foundation reveals. They are as hard as steel, can be machined and worked, and are as strong as much steel now in use; but they will not corrode and rust like the more familiar metal. Research has already developed both for practical application.

Everdur is a product of necessity found by Charles B. Jacobs, of the du Pont Company, during the World War when a fairly cheap metal that would withstand the attack of acids was needed in chemical plants. Mr. Jacobs knew that silicon, which, combined with oxygen, is as plentiful as ordinary sand, was being produced in commercial quantities at a reasonable cost. He mixed a little silicon with copper and obtained a good acid-resistant metal. Later researches led to the addition of a small quantity of manganese.

Tempaloy, as its name indicates, undergoes peculiar changes when heated in different ways. When heated to 750 or 800 degrees centigrade and then chilled, it is soft and ductile and can be readily worked cold. When at 450 degrees for a few hours it becomes lastingly hard. In fact, Tempaloy is a copper that can be tempered, in the modern phraseology, as steel is tempered. This alloy is made of copper, silicon, and nickel and is the result of researches by Michael G. Corson in the Union Carbon and Carbide research laboratories.—*Science Service*

A SIMPLE PROOF OF THE STEREOCHEMICAL CONFIGURATIONS OF *d*-GLUCOSE AND OF *d*-GALACTOSE*

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The recent work of Haworth and co-workers[1] on the position of the oxygen bridge in the formulas of the normal reducing sugars has made possible the derivation of their stereochemical configuration by a method which is much more simple and direct than the classic ones which it has been necessary to use up to the present time,[2] and which students often find troublesome to follow and master.

After the configuration of the pentoses, as developed, for example, by Armstrong[2] has been demonstrated, that of the epimeric hexoses derived from *d*-arabinose may be deduced by the following method:

(1) *d*-Glucose (I or II) and *d*-mannose (I or II) are formed by the cyanhydrin synthesis from *d*-arabinose. Therefore it follows that both these hexoses contain an arabinose configuration of substituents on carbon atoms 3, 4, and 5, and it remains only to determine the configuration of the groups about carbon atom 2 in the respective epimers.

(2) Haworth has demonstrated that oxidation of 2,3,4,6-tetramethyl-*d*-glucose yields xylo-2,3,4-trimethoxyglutaric acid, which is also formed by oxidation of 2,3,4-trimethyl-*d*-xylose. Therefore 2,3,4,6-tetramethyl-*d*-glucose must contain the same asymmetric system as 2,3,4-trimethyl-*d*-xylose, and the original *d*-glucose must contain a *d*-xylose residue. This xylose residue must be derived from a sequence of carbon atoms other than the 3,4,5 atoms, which represent the arabinose system. The only other possible sequence of three asymmetric carbon atoms in glucose is the 2,3,4 series. Therefore, it follows that the hydrogen and hydroxyl groups attached to carbon atoms 2, 3, and 4 must be arranged in the same asymmetric manner as in *d*-xylose.

Thus, in *d*-glucose, carbon atoms 3, 4, and 5 constitute the *d*-arabinose residue and carbon atoms 2, 3, and 4 the *d*-xylose portion. Whence the complete formula (I) for *d*-glucose is at once evident.

The structure of mannose is derived from the fact that it is the epimer of glucose and hence differs from it only in the orientation of the groups around carbon atom 2, and therefore mannose must have formula II. The independent derivation of the formula of mannose by reasoning

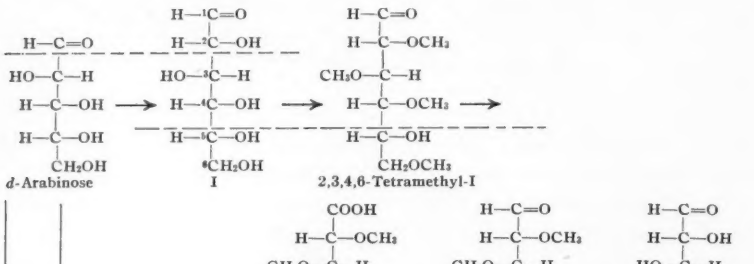
* Contribution No. 95 from the Carbohydrate Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.

[1] Haworth, "The Constitution of the Sugars," Longmans, Green & Co., London, **1929**, pp. 1–46.

[2] E. Fischer, "Synthesen in der Zuckergruppe, II," *Ber.*, **27**, 3189 (1894). E. F. Armstrong, "The Simple Carbohydrates and the Glucosides," Longmans, Green & Co., London, **1924**, pp. 33–6. M. Cramer, "Les Sucres et leurs Dérivés," Dion, Paris, **1927**, pp. 139–51. J. B. Cohen, "Organic Chemistry for Advanced Students," Part III, Longmans, Green & Co., New York, **1928**, pp. 24–31.

analogous to that just given is impossible owing to the fact that on oxidation the tetramethyl mannose yields 2,3,4-trimethoxy-*d*-glutaric acid, a derivative common to both *d*-arabinose and *d*-lyxose. This throws no light on the asymmetry of carbon atom 2, because Haworth's oxidation method does not in itself exclude the possibility of the identity of this *d*-arabinose system with that already known to be present by reason of the possible synthesis of mannose from *d*-arabinose.

The reasoning applicable to the derivation of the configuration of *d*-glucose is valid also for the epimeric pair, *d*-galactose and *d*-talose. These may be synthesized from *d*-lyxose, and this fixes the orientation of the groups about carbon atoms 3, 4, and 5. *d*-Galactose yields by methylation and oxidation, according to Haworth, 2,3,4-trimethoxy-*l*-glutaric acid, which is a derivative of *l*-arabinose. Thus, *d*-galactose contains both a *d*-lyxose and an *l*-arabinose system, and the complete formula is evident.



Since Haworth has not yet reported on the oxidation products of *d*-talose, its configuration is obtained by the same procedure as that used for mannose. For the other rare aldohexoses, Fischer's method must be used, since these sugars have not yet been studied by the methylation and oxidation method.

The aldehydic formulas on page 1600 illustrate more clearly than is possible in words the chain of reasoning.

British Science Association to Celebrate 100th Birthday. Gen. Jan Smuts, soldier, statesman, and philosopher, once a formidable enemy of England and now a pillar of the Empire, has been chosen for the unique honor of presiding over the largest of British scientific organizations, the British Association for the Advancement of Science, when it celebrates the hundredth anniversary of its organization in London in 1931.

Gen. Smuts is the first president of the Association to be chosen from any of the British dominions overseas. He is not, however, the first president who was not a professional scientist, for several prominent British public men have presided in past years, and in 1926 the Prince of Wales delivered the presidential address at Oxford.

Although Gen. Smuts is not a research scientist, he has high standing in scientific circles because of his work in the field of scientific philosophy. He is the author of a book on what he has termed "holism," a concept of the way organisms work in their individual lives and in the chain of development we know as evolution, which is recognized as a genuine and thoughtful contribution. His line of thought is akin to the ideas put forth by other scientists under the captions of "emergent evolution," "organismalism," etc. It stresses the necessity of considering the interaction of all the life factors, rather than the concentration of attention on one or a few as the key to the riddle of vital existence.

The British Association for the Advancement of Science was organized at York, England, in 1831. York was chosen as the most central city of the British Isle. Since the outlook of the Association is now as wide as the Empire, it has been decided that the appropriate meeting place for the centenary celebration should be London, the heart of the Empire, although previously no British Association meeting has ever been held there.—*Science Service*

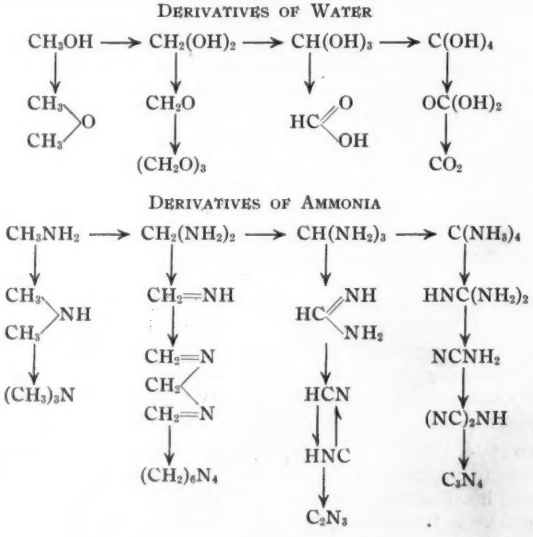
Nitrogen of Air Fixed by Lowly Scum-Weed. Bacteria, which have hitherto had a nearly complete monopoly on the important business of capturing nitrogen from the air and making it available for the feeding of higher plants, may have to yield a part of their throne to larger but almost equally humble plants, the blue-green algae. Experiments reported to the technical journal, *Science*, by Dr. F. E. Allison and H. J. Morris of the U. S. Department of Agriculture indicate that at least one species of blue-green algae, kin to the multitudinous plants that give color to stagnant water, is able to fix nitrogen in considerable quantity when supplied with normal sunlight, or in the absence of sunlight if it is given sugar.

Earlier experiments had indicated something of the kind, but the two Government scientists wanted to check up under more rigid control conditions, so they repeated the work with more elaborate precautions. One of the greatest difficulties was to get a culture of the algae without any bacteria in it, for bacteria have a habit of sticking very tightly to the slimy sheaths of the larger plants. They finally cleared their algae of the last bacterium by irradiating it with ultra-violet light, which kills bacteria but does not harm the algae in the doses used.—*Science Service*

LIQUID AMMONIA AS A SOLVENT AND THE AMMONIA SYSTEM OF COMPOUNDS. VI. ORGANIC AMMONIA COMPOUNDS. PART II. THE NITROGEN ANALOGS OF THE ALDEHYDES, KETONES, CARBOXYLIC ACIDS, AND CARBONIC ACIDS. AMMONO CARBONOUS ACID[1]

W. Conard Fernelius, The Ohio State University, Columbus, Ohio, and Warren C. Johnson, University of Chicago, Chicago, Illinois

In the introductory portion of this article[2] the formal resemblance of the simple nitrogen compounds of carbon to the familiar oxygen compounds of carbon was pointed out and a nitridation scheme was developed to show the interrelationships of these nitrogen compounds. In addition the ammono alcohols and ethers (the amines) were discussed in some detail. With this nitridation scheme in mind let us now turn to a consideration of the other substances represented there.



Ammono Aldehydes and Ketones

The aldehydes and ketones, characterized by an oxygen atom doubly bound to a carbon atom, form a definite and very interesting group of organic compounds. Similarly, the ammono aldehydes and ammono

[1] Previous articles in this series have appeared as follows: I, This Journal, **5**, 664 (June, 1928); II, *Ibid.*, 828 (July, 1928); III, *Ibid.*, **6**, 20 (Jan., 1929); IV, *Ibid.*, 441 (Mar., 1929); V, *Ibid.*, **7**, 981–99 (May, 1930); VI, Part I, *Ibid.*, 1291–9 (June, 1930).

[2] This Journal, **7**, 1291–9 (June, 1930).

ketones contain a carbon atom doubly bound to nitrogen. Here again the distinction between the two types lies in the presence or absence of a hydrogen atom attached to the carbon atom concerned. The aldimines and ketimines are thus ammono aldehydes and ammono ketones, respectively.

ALDEHYDES	KETONES
$CH_3CH{=}O$	$(CH_3)_2C{=}O$
$CH_3CH{=}NH$	$(CH_3)_2C{=}NH$
$CH_3CH{=}NR$	$(CH_3)_2C{=}NR$

At the start it should be stated that the relationships of the ammono aldehydes and ketones to the familiar water compounds, which are quite evident after a little study, are somewhat complicated because of the trivalence of nitrogen which makes possible a greater number of combinations than is possible in the case of divalent oxygen.[3] With this idea in mind it is seen that such compounds as $C_6H_5CH{=}NH$, although aldehydes because of the possession of a double bond, $-CH{=}N-$, also contain a hydrogen atom attached to nitrogen, in which respect they resemble the ammono alcohols.[4] These aldimines, therefore, should exhibit alcoholic properties and might well be termed ammono aldehyde-alcohols. As a matter of fact the hydrogen of the aldimines is readily replaceable by metals to give derivatives analogous to potassium ethylate,[5]

$$C_6H_5CH{=}NH + KNH_2 \longrightarrow C_6H_5CH{=}NK + NH_3$$

The acetals are derivatives of the aldehydes resembling on the one hand the ethers and on the other the esters. They are easily made by the interaction of an aldehyde, and an alcohol in the presence of anhydrous hydrogen chloride,

$$CH_3CH{=}O + 2CH_3OH \longrightarrow CH_3CH(OCH_3)_2 + H_2O.$$

Similarly, when an amine is used in place of an alcohol there is formed a substance which may rightly be termed an ammono acetal,

$$CH_3CH{=}O + 2(CH_3)_2NH \longrightarrow CH_3CH[N(CH_3)_2]_2 + H_2O.$$

No such ammono acetals are known in the case of the primary amines; instead, there are formed substances of this type, $CH_3CH{=}NR$, the Schiff

[3] The nitrogen analogs of the well-known oxygen compounds are not to be regarded as being derived solely, as many have supposed, by the substitution of $-NH_2$ for $-OH$ and $=NH$ for $=O$ but rather, in the broader sense, as the substitution of trivalent nitrogen for divalent oxygen.

[4] Ref. 2, p. 1294.

[5] Strain, *J. Am. Chem. Soc.*, **49**, 1563 (1927). It might be said with equal justification that an aldimine possesses acidic rather than alcoholic properties and should be called an aldehyde acid. Perhaps, as Bergstrom has suggested, it is better to compare the aldimines, $RCH{=}NH$, to aldehyde hydrates, $CCl_3CH(OH)_2$.

bases [$CH_3CH(NHR)_2 \longrightarrow CH_3CH{=}NR + RNH_2$]. These alkyl and aryl derivatives of the amines must be regarded as ammono acetals (because of the nitrogen to hydrocarbon radical linkage, =N—R) as well as ammono aldehydes (because of the double bond, —HC=N—) and may rightly be called ammono aldehyde-acetals.[6,7]

Upon the loss of ammonia, the imines are converted into hydramides,

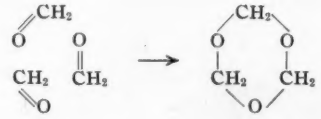
$$3C_6H_5CH{=}NH \longrightarrow C_6H_5CH\begin{matrix}\diagup C_6H_5CH{=}N \\ \diagdown C_6H_5CH{=}N\end{matrix} + NH_3.$$

These hydramines contain two true ammono aldehyde groups, —CH=N—, and one other group which is very similar to the acetals in that two valences of the central carbon atom are satisfied by two nitrogen atoms rather than by the same nitrogen atom. The hydramides then are further examples of aldehyde-acetals.

Ketone-like substances other than the ketimines would be the following,

$$\begin{matrix}CH_3 \\ CH_3\end{matrix}\!\!\diagdown C{=}NR \qquad (CH_3)_2C{=}N \\ (CH_3)_2C\begin{matrix}\diagup \\ \diagdown\end{matrix} \\ (CH_3)_2C{=}N$$

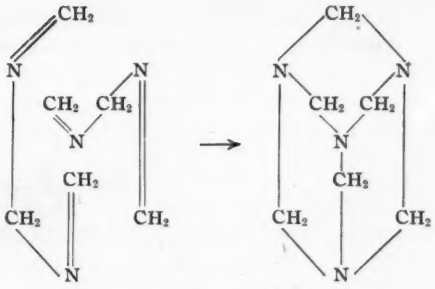
Polymerization.—One of the outstanding characteristics of the aldehydes is their marked tendency to polymerize. Apparently such polymerization relieves the strain introduced into the molecule by the double bond between carbon and oxygen. Thus three molecules of formaldehyde readily coalesce to the familiar trioxymethylene ring and acetaldehyde forms metaldehyde and paraldehyde. When formaldehyde is treated with ammonia there is formed neither methylene imine, $CH_2{=}NH$, nor methylene nitride, $(CH_2)_3N_2$, but instead hexamethylene tetramine, $(CH_2)_6N_4$, a dimer of methylene nitride. The closely parallel polymerization reactions are represented by the schemes,



and

[6] It is interesting to note that according to these ideas pyridine, HC$\begin{matrix}\diagup CH{=}CH\diagdown \\ \diagdown CH{=}CH\diagup\end{matrix}$N, is formally a cyclic ammono aldehyde acetal. Numerous reactions of pyridine support this hypothesis (Bergstrom, Swampscott Meeting, A. C. S., Sept., 1928).

[7] Because of the resemblances which the aldimines bear to alcohols and to acids, substances of the type $C_6H_5CH{=}NR$ might also be called aldehyde ethers or aldehyde esters although the term aldehyde-acetal is perhaps to be preferred.



Because of the trivalence of nitrogen a simple ring is impossible so that a multi-ringed compound is formed of which the above is a plane projection. As ordinarily prepared, ethylene imine exists as the trimer $(CH_3CH{=}NH)_3$.[8]

Addition Compounds.—The oxygen aldehydes have a marked power to form addition compounds with numerous substances such as hydrocyanic acid and sodium acid sulfite, .

$$C_6H_5CHO + HCN \longrightarrow C_6H_5CH(CN)OH$$
$$C_6H_5CHO + NaHSO_3 \longrightarrow C_6H_5CH(OH)SO_2ONa$$

Similar reactions are known for the ammono benzaldehydes. For example, hydrocyanic acid adds directly to both hydrobenzamide[9] and the Schiff bases,[10]

$$\begin{matrix} C_6H_5CH{=}N \\ C_6H_5CH\!\!< \\ C_6H_5CH{=}N \end{matrix} + 2HCN \longrightarrow \begin{matrix} C_6H_5CH(CN)NH \\ C_6H_5CH\!\!< \\ C_6H_5CH(CN)NH \end{matrix}$$

$$C_6H_5CH{=}NC_6H_5 + HCN \longrightarrow C_6H_5CH(CN)NHC_6H_5$$

and sulfurous acid (moist sulfur dioxide) forms an addition compound with hydrobenzamide,[11]

$$\begin{matrix} C_6H_5CH{=}N \\ \quad\quad\quad\quad CHC_6H_5 \\ C_6H_5CH{=}N \end{matrix} + 2H_2SO_3 \longrightarrow \begin{matrix} C_6H_5CH{-}SO_2OH \\ \quad\quad\quad\quad NH \\ \quad\quad\quad\quad CHC_6H_5 \\ \quad\quad\quad\quad NH \\ C_6H_5CH{-}SO_2OH \end{matrix}$$

[8] Delépine, *Compt. rend.*, **125,** 951 (1897); **128,** 105 (1899); *Ann. chim. phys.*, [7], **16,** 103 (1899); *Bull. soc. chim.*, [3] **21,** 58 (1899).

[9] Plöchl, *Ber.*, **13,** 2118 (1880); **14,** 1139 (1881).

[10] Cech, *Ber.*, **11,** 246 (1878).

[11] Otto, *Ann.*, **112,** 305 (1859); van de Griendt, Thesis, Stanford University, **1926.**

In the latter case, probably because of the formation of an inner ammonium salt, sulfurous acid itself forms a stable compound while only the salts are stable in the case of the aquo aldehydes. If a slight excess of water is added, the hydrobenzamide addition product hydrolyzes, forming two molecules of the addition compound of benzylidene imine, $C_6H_5CH(NH_2)$-$OSO{\cdot}OH$ or $C_6H_5CH\begin{<}NH_3\\O{\cdot}SO\end{>}O$ and one of benzaldehyde.

Oximes and Phenylhydrazones.—Closely related to the formation of addition compounds of the aldehydes is the formation of oximes and phenylhydrazones. Hydroxylamine and phenylhydrazine react readily with the aquo aldehydes to form the characteristic reaction product and water,

$$C_6H_5CHO + H_2NOH \longrightarrow C_6H_5CH{=}NOH + H_2O$$
$$C_6H_5CHO + H_2N{\cdot}NHC_6H_5 \longrightarrow C_6H_5CH{=}N{\cdot}NHC_6H_5 + H_2O$$

The ammono aldehydes react with these same reagents to form the same oximes and phenylhydrazones and ammonia in place of the water above. The following equations illustrate these reactions,

$$C_6H_5CH{=}NH + H_2NOH \longrightarrow C_6H_5CH{=}NOH + NH_3{}^{12}$$
$$\begin{matrix}C_6H_5CH{=}N\\ C_6H_5CH\\ C_6H_5CH{=}N\end{matrix}\!\!\!

$$\begin{matrix} C_6H_5CH{=}N \\ C_6H_5CH\!\!\!\diagup \\ C_6H_5CH{=}N \end{matrix} + 2C_2H_5MgBr \longrightarrow \begin{matrix} C_6H_5CH(C_2H_5){-}N{-}MgBr \\ C_6H_5CH\!\!\!\diagup \\ C_6H_5CH(C_2H_5){-}N{-}MgBr \end{matrix} \xrightarrow{3\ H_2O}$$

$$C_6H_5CHO + 2\begin{matrix} C_6H_5 \\ C_2H_5 \end{matrix}\!\!\!\diagup CHNH_2 + 2BrMgOH^{14}$$

Reduction and Nitridation.—Since the aldehydes constitute the first oxidation (nitridation) step beyond the primary alcohols, it is to be expected that the aldehydes would be capable of reduction to the corresponding alcohols. Such a reduction readily takes place in the case of hydrobenzamide. On treatment with a solution of sodium in liquid ammonia,[15] benzyl amine is formed in abundant yield.[16] In alcoholic solution with sodium amalgam, hydrobenzamide gives benzyl amine and dibenzyl amine, both of which are primary ammono alcohols.[17] Benzylidene aniline is also reduced by nascent hydrogen to a secondary amine which is a primary ammono alcohol,[18]

$$C_6H_5CH{=}NC_6H_5 + 2H \longrightarrow C_6H_5CH_2{-}NH{-}C_6H_5.$$

Aldehydes are readily oxidized to the corresponding carboxylic acid,

$$C_6H_5CHO + O \longrightarrow C_6H_5COOH.$$

Similarly, benzylidene imine is nitridized to the ammonia analog of benzoic acid, benzamidine, by a liquid ammonia solution of iodine.[19,20]

$$C_6H_5CH{=}NH + H_2NI \longrightarrow HI + C_6H_5C(NH)NH_2$$

Moreover, by the action of hydrazoic acid in liquid ammonia solution at 100°, hexamethylene tetramine has been nitridized to guanidine—a reaction strictly analogous to the oxidation of trioxymethylene to carbon dioxide.[21]

Cannizzaro Reaction.—One of the most characteristic reactions of the aromatic aquo aldehydes is the Cannizzaro reaction in which equal quantities of an alcohol and a carboxylic acid are formed by treating the aldehyde with a solution of a strong base,

[14] Busch and Leefhelm, *J. prakt. Chem.*, [2] **77,** 1 (1908).

[15] For a discussion of a liquid ammonia solution of sodium as a reducing agent see THIS JOURNAL, **6,** 34 (Jan., 1929).

[16] Ref. 5, p. 1562.

[17] Fischer, *Ber.*, **19,** 748 (1886); *Ann.*, **241,** 328 (1887).

[18] Schiff, *Ann. Chem. Suppl.*, **3,** 354 (1864).

[19] For a discussion of a liquid ammonia solution of iodine as a nitridizing agent, see THIS JOURNAL, **7,** 1298 (June, 1930).

[20] Ref. 5, p. 1564. That a portion of the benzamidine deammonates to phenyl cyanide, benzoic anammonide, which for the most part polymerizes to cyanphenine, $(C_6H_5CN)_3$, the trimer of phenyl cyanide, does not invalidate the analogy.

[21] Franklin, "Reactions in Liquid Ammonia," Columbia Univ. Press, New York, 1927.

$$2C_6H_5CHO + KOH \longrightarrow C_6H_5CH_2OH + C_6H_5COOK.$$

Similarly, benzylidene imine, when heated with potassium amide (an ammono base) in liquid ammonia solution, undergoes intermolecular oxidation (nitridation) and reduction to give benzyl amine (ammono benzyl alcohol) and benzamidine (ammono benzoic acid),

$$2C_6H_5CH{=}NH + KNH_2 \longrightarrow C_6H_5CH_2NH_2 + C_6H_5C(NH)NHK.$$

An interesting variation of this type of reaction is that between an ammono base and an aquo aldehyde in which an aquo alcohol and a mixed aquo ammono acid are formed,[22]

$$2C_6H_5CHO + NaNH_2 \longrightarrow C_6H_5CH_2OH + C_6H_5CONHNa$$

Benzylidene aniline undergoes a Cannizzaro reaction although the products, acid and alcohol, are combined as an ester,[23]

$$2C_6H_5CH{=}NC_6H_5 + KNH_2 \longrightarrow C_6H_5C\begin{matrix}NCH_2C_6H_5\\ NK\cdot C_6H_5\end{matrix} + \text{[illegible]}$$

Benzoin Condensation.—Benzoin is a substance formed by the condensation of two molecules of benzaldehyde in the presence of cyanide ion,

$$\begin{matrix}C_6H_5CHO\\ C_6H_5CHO\end{matrix} \longrightarrow \begin{matrix}C_6H_5CHOH\\ |\\ C_6H_5C{=}O\end{matrix}$$

The reaction apparently takes place through the migration of hydrogen from the carbon of one —CHO group to the oxygen of another molecule and the establishment of a bond between carbon atoms. When hydrobenzamide is heated, an isomeric compound, amarine, results. Its formation may be looked upon, for the first step, as an example of a benzoin condensation because there is a shift of hydrogen from carbon to nitrogen and the establishment of a bond between carbon atoms,[24]

$$\begin{matrix}C_6H_5CH{=}N\\ \quad\quad\quad\

$$2C_6H_5CH{=}NC_6H_5 \longrightarrow \begin{matrix} C_6H_5CH{-}NHC_6H_5 \\ | \\ C_6H_5C{=}NC_6H_5 \end{matrix}$$

The analogy does not stop here, however, for just as benzoin is oxidized to benzil so is benzoin-anil-anilide nitridized by a liquid ammonia solution of iodine to benzil-dianil, an ammono benzil,[25]

$$\begin{matrix} C_6H_5CHOH \\ | \\ C_6H_5C{=}O \end{matrix} + O \longrightarrow \begin{matrix} C_6H_5C{=}O \\ | \\ C_6H_5C{=}O \end{matrix} + H_2O$$

$$\begin{matrix} C_6H_5CH{-}NHC_6H_5 \\ | \\ C_6H_5C{=}NC_6H_5 \end{matrix} + NH \longrightarrow \begin{matrix} C_6H_5C{=}NC_6H_5 \\ | \\ C_6H_5C{=}NC_6H_5 \end{matrix} + NH_3$$

The Carbazylic Acids

Carbon, in the aldehyde-ketone stage of oxidation (nitridation or deelectronation) has two of its valences attached to oxygen or nitrogen. In that state of oxidation exemplified by the carbazylic acids, three of the valences of a single carbon atom are attached to oxygen. The formal nitrogen analogs of the carboxylic acids would be the amidines which might rightly be called *carbazylic acids* especially

$$RC\begin{matrix} =O \\ -OH \end{matrix} \qquad RC\begin{matrix} =NH \\ -NH_2 \end{matrix}$$

since they show acid properties in liquid ammonia solution.[26] Acetamidine and benzamidine, two representative carbazylic acids, react, in liquid ammonia solution, with potassium amide as represented by the equation,

$$RC\begin{matrix} =NH \\ -NH_2 \end{matrix} + KNH_2 \longrightarrow RC\begin{matrix} =NH \\ -NHK \end{matrix} + NH_3$$

to form, respectively, a potassium ammono acetate and a potassium ammono benzoate.[27]

Salts of the carbazylic acids are also formed by the direct addition of metallic amides to nitriles. For example, ethyl cyanide, which is the anammonide of ammono propionic acid, reacts with potassium amide, an ammono base, to form potassium ammono propionate just as propionic

[25] Strain, *J. Am. Chem. Soc.*, **51**, 269 (1929).

[26] The amidines are usually recognized as being basic substances. The basic nature of the amidines in the presence of water is due to the formation of an addition compound with water which dissociates to give hydroxyl ion just as does ammonium hydroxide. Thus, guanidine, a weak ammono acid in liquid ammonia solution, forms a very strong base in water solution, guanidinium hydroxide. Many acids which are unrecognizable as acids in aqueous solution have been found to show distinct acid properties in liquid ammonia solution because of the difference between the physical properties of water and liquid ammonia. *Cf.* THIS JOURNAL, **5**, 833 (July, 1928).

[27] Benedict, Thesis, Stanford University, 1924.

anhydride reacts with potassium hydroxide to form potassium aquo propionate. The parallel reactions are represented by the equations,

$$C_6H_5CN + KNH_2 \longrightarrow C_6H_5C(=NH)NHK$$

$$(C_6H_5CO)_2O + 2KOH \longrightarrow 2C_6H_5COOK + H_2O$$

The one reaction takes place in liquid ammonia solution, the other in water. The potassium salts of palmitamide and stearamide, ammono soaps, behave like soaps in liquid ammonia solution in that they lower the surface tension of the solvent and promote frothing. Further evidence that the cyanides are to be regarded as anammonides of the carbazylic acids is furnished by the observation that methyl cyanide, heated in liquid ammonia with ammonium chloride, ammonates to acetamidine. The amidines are known to lose ammonia rather easily to form the corresponding cyanides.

The close relationship existing between the carboxylic acids and carbazylic acids is further shown by such reactions as are represented by the equations,

$$CH_3C(=O)OK + KOH \longrightarrow CH_4 + K_2CO_3$$

$$CH_3C(=NH)NHK + KNH_2 \longrightarrow CH_4 + K_2CN_2 + NH_3$$

Just as potassium aquo acetate when heated with potassium hydroxide yields methane and potassium aquo carbonate, so when a mixture of potassium ammono acetate and potassium amide is heated, methane and potassium ammono carbonate are formed.[28]

The alkyl and aryl substituted amidines are to be regarded as esters. Reactions illustrated by the following equations substantiate this view,

$$C_6H_5C(=NC_6H_5)NH_2 + C_6H_5NH_2 \longrightarrow C_6H_5C(=NC_6H_5)NHC_6H_5 + NH_3$$[29]

$$CH_3C(=NC_6H_5)NHC_6H_5 + 2NH_3 \longrightarrow CH_3C(=NH)NH_2 + 2C_6H_5NH_2$$[30]

The first equation, a typical esterification, illustrates the formation of a diphenyl ester of ammono benzoic acid and ammonia by the reaction of an acid ester of ammono benzoic acid with an ammono alcohol and the latter illustrates the ammonolysis (saponification) of an ester of ammono acetic acid to ammono acetic acid and ammono phenyl alcohol.

[28] Cornell, *J. Am. Chem. Soc.*, **50**, 3311 (1928).
[29] Bernthsen, *Ann.*, **184**, 349 (1876).
[30] Niemann, Thesis, Stanford University, **1926**.

The cyanides form with Grignard's reagents addition compounds, which upon treatment with liquid ammonia (ammonolysis), yield ketimines (ammono ketones),[31]

$$C_6H_5CN + C_6H_5MgBr \longrightarrow C_6H_5C(=NMgBr)C_6H_5$$

$$(C_6H_5)_2C{=}NMgBr + NH_3 \longrightarrow (C_6H_5)_2C{=}NH + BrMgNH_2.$$

This synthesis differs in no essential from the production of ketones through the interaction of acid anhydrides and Grignard's reagents,

$$(C_2H_5C(=O))_2O + 2C_2H_5MgBr \longrightarrow (C_2H_5)_2C(OMgBr)O(OMgBr)C(C_2H_5)_2$$

$$(C_2H_5)_2C(OMgBr)O(OMgBr)C(C_2H_5)_2 + H_2O \longrightarrow 2(C_2H_5)_2CO + 2BrMgOH$$

Hydrocyanic Acid[32]

Because hydrocyanic acid bears a somewhat complicated relationship to the ammonia system it is necessary to consider this substance in some detail. The work of Nef leaves no question as to the existence of divalent carbon in the isocyanides and in hydrocyanic acid. Today, hydrocyanic acid is regarded as a tautomeric substance,

$$HNC \rightleftharpoons HCN$$

According to the first formula hydrocyanic acid is an ammono carbonous acid and according to the second formic anammonide. It might also be expected that hydrocyanic acid would show the properties of an aldehyde since all of the valences of the nitrogen atom are attached to a single carbon atom just as all valences of oxygen are attached to a single carbon atom in formaldehyde ($HC{\equiv}N$, $H_2C{=}O$, the triple bond, $-C{\equiv}N$, here being in a way analogous to the double bond, $=C{=}O$). The existence of this tautomerism is not surprising in view of the well-known tautomerism of the -ous acids of phosphorus, nitrogen, and sulfur, as represented by the following equilibria,

$$P(OH)_3 \rightleftharpoons HPO(OH)_2$$

$$ONOH \rightleftharpoons HNO_2$$

$$SO(OH)_2 \rightleftharpoons HSO_2OH$$

[31] Moreau and Mignonac, *Compt. rend.*, **156**, 1790 (1900); Ref. 28.

[32] For a complete discussion of the relationship of hydrocyanic acid to the ammonia system of compounds and for complete references, see Franklin, *J. Phys. Chem.*, **27**, 1671 (1923).

The surprising thing is that no similar tautomerism has been observed in the behavior of formic acid and formamidine (ammono formic acid). There remains to consider the evidence that hydrocyanic acid possesses the properties, first, of ammono carbonous acid; second, of formic anammonide; and, third, of an aldehyde.

Ammono Carbonous Acid.—Carbon monoxide theoretically should be the anhydride of carbonous acid.[33]

$$C\begin{matrix}OH\\OH\end{matrix} \xrightarrow{-H_2O} C{=}O$$

$$C\begin{matrix}NH_2\\NH_2\end{matrix} \xrightarrow{-NH_3} C{=}NH \xrightarrow{-NH_3} C_3N_2$$

In this connection it is interesting to note that sodium cyanide is formed by the action of carbon monoxide upon sodium amide,

$$CO + NaNH_2 \longrightarrow C{=}NNa + H_2O$$

This reaction is in harmony with the view that hydrocyanic acid is ammono carbonous acid in that the reaction may be regarded as the formation of water (subsequently decomposed by the excess of sodium amide) and an ammono carbonite from carbonous anhydride and an ammono base.

Hydrocyanic acid may be nitridized to the ammono carbonic acid, cyanamide, in liquid ammonia solution,

$$NH_4NC + H_2NI \longrightarrow HN{=}C{=}NH \ (\rightleftharpoons H_2NCN) + NH_4I$$

Similar nitridations involving the alkali cyanides are represented by the following equations,

$$NaNC + NaN_3 \longrightarrow Na_2NCN + N_2$$

$$NaNC + NaNH_2 \longrightarrow Na_2NCN + H_2$$

These reactions differ in no essential from the oxidation of the cyanides to cyanates,

$$2NaNC + O_2 \longrightarrow 2NaNCO$$

Disodium cyanamide (an ammono carbonate) is reduced to sodium cyanide by elementary carbon,

$$Na_2NCN + C \longrightarrow 2NaNC$$

Finally, ethyl carbylamine (isocyanide) which is an ester of ammono carbonous acid is saponified by potassium amide to potassium cyanide and ethyl amine (an ammono alcohol),

$$C_2H_5NC + KNH_2 \longrightarrow KNC + C_2H_5NH_2$$

[33] Scheibler's carbon monoxide diethylacetal, $C(OC_2H_5)_2$ [*Ber.*, **59**, 1022 (1926)], may be regarded as the diethyl ester of carbonous acid.

Carbonous nitride, C_3N_2, the end-product of deammonation of ammono carbonous acid is unknown.[34]

Formic Anammonide.—In support of the idea that hydrocyanic acid is the anammonide of formic acid, the following facts are offered: first, hydrocyanic may be converted (hydrolysis) successively into formamide and formic acid,

$$HCN \longrightarrow HC\begin{matrix}=O\\ -NH_2\end{matrix} \longrightarrow HC\begin{matrix}=O\\ -OH\end{matrix}$$

Second, formamidine hydrochloric is deammonated to hydrocyanic acid on gentle heating,

$$HC(NH)NH_2 \cdot HCl \longrightarrow HCN + NH_4Cl.$$

Third, in the presence of hydrochloric acid and alcohol, hydrocyanic acid is esterified to an ester of mixed aquo ammono formic acid,

$$HCN + C_2H_5OH \longrightarrow HC(NH)OC_2H_5.$$

Fourth, by the addition of the Grignard reagent and subsequent hydrolysis of the product formed, hydrocyanic acid may be converted into an aldehyde in the same manner as the closely related ortho aquo formic esters,

$$RMgBr + HCN \longrightarrow RHC = NMgBr \xrightarrow{H_2O} RHCO + BrMgOH + NH_3{}^{35}$$

$$RMgBr + HC(OC_2H_5)_3 \longrightarrow C_2H_5OMgBr + RHC(OC_2H_5)_2 \xrightarrow{H_2O} 3C_2H_5OH + RHCO + BrMgOH.$$

Aldehyde Properties of Hydrocyanic Acid.—Assuming hydrocyanic acid to have the formula, HC≡N, it is to be expected that this compound, because of its triple bond, nitrogen to carbon, and because of certain resemblances between the carbonyl and cyanogen groups, would exhibit aldehydic properties. As a matter of fact hydrocyanic acid shows conspicuously most of the properties characteristic of the aldehydes some of which are discussed below. It shows the same strong tendency to polymerization as does formaldehyde, yielding a polymeric modification which reverts to the monomolecular form on strong heating. Hydrocyanic acid undergoes condensation in a manner strictly analogous to the familiar aldol condensation characteristic of the aldehydes,

$$2CH_2O \longrightarrow CH_2OH \cdot CHO,$$

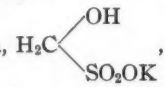
$$2HCN \longrightarrow CH(=NH)CN + HCN \longrightarrow HC(CN)_2NH_2$$

[34] The "Stickkohlenstoff," $(C_3N_2)_x$, reported by Pauly [*Ber.*, **43**, 2243 (1910)], and obtained by the thermal decomposition of tetraiodoimidazole, $\begin{matrix}CI-NI\\ \|\\ CI-N\end{matrix}\!\!>\!\!CI$, has been shown to be a mixture of carbon and paracyanogen $(C_2N_2)_x$ [Wenzel, Dissertation, Stanford University, 1927].

[35] Bodroux, *Compt. rend.*, **138**, 92, 700 (1904).

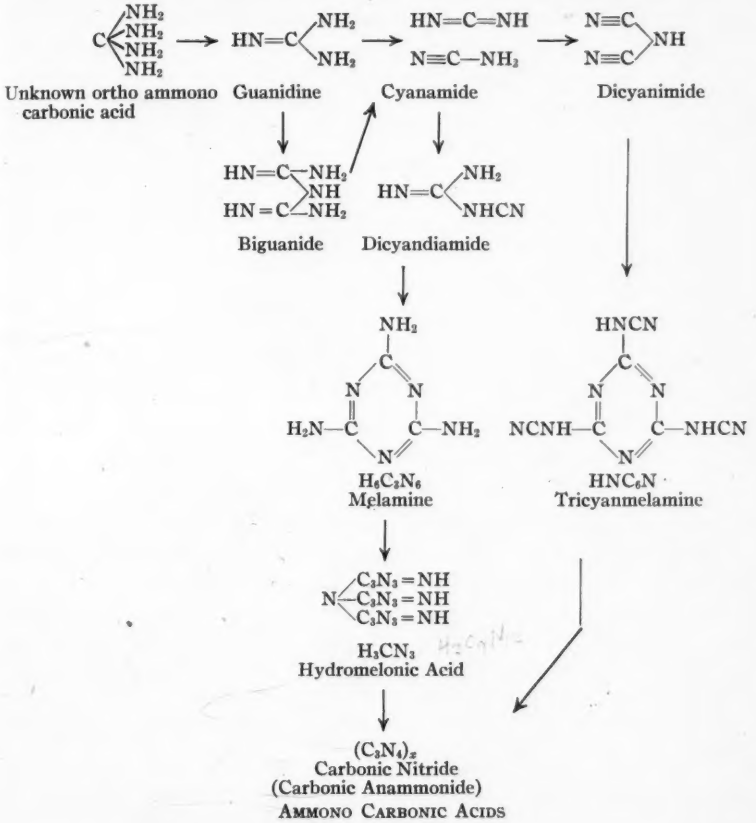
The triple bond between carbon and nitrogen as contrasted with a double bond between carbon and oxygen permits the reaction to proceed farther to a trimolecular condensation product. Sodium and potassium acid sulfites form compounds with hydrocyanic acid of the type,

, which are obviously the analogs of the compound of the formula,



, formed by the action of potassium acid sulfite on formaldehyde. Furthermore, hydrazine reacts with hydrocyanic acid in a manner essentially similar to its reaction with formaldehyde. The following equations represent these analogous reactions:

$$2HCN + 3H_2N{\cdot}NH_2 \longrightarrow \begin{matrix} HC{=}N{\cdot}NH_2 \\ \quad\quad\quad\



Salts of nearly all of the ammono carbonic acids have been prepared, some in ammonia solution, some in aqueous solution.[37] Solutions of these salts as well as those of the acids themselves conduct the electric current, the former with a much greater facility than the latter.[38] The existence of so many closely related compounds offers an excellent opportunity to study the effect of the number of replaceable hydrogen atoms in the molecule of acid and the effect of polymerization upon the acid strength of these acids. In this connection, it is interesting to note that the conductivity of both acids and salts, in so far as it has been measured, increases with deammonation of the acids and decreases with polymerization.[38] So that, for example, while guanidine and biguanide are extremely weak

[37] Ref. 36; Franklin and Stafford, *Am. Chem. J.*, **28**, 83 (1902).
[38] Smith, *J. Am. Chem. Soc.*, **49**, 2162 (1927).

acids whose salts are completely hydrolyzed in water solution and dicyandiamide, melamine and cyanamide are stronger in the order named, tricyanmelamine, hydromelonic acid and dicyanimide are easily recognized as acids in water solution and are little inferior in strength to the ordinary mineral acids.[21] This situation is similar to that among the phosphorous acids; metaphosphorous acid, HPO_2, is a stronger acid than the fully hydrated orthophosphorous acid, $(HO)_3P$.

Many esters of the ammono carbonic acids are known such as triphenyl guanidine and the dialkyl cyanamides,

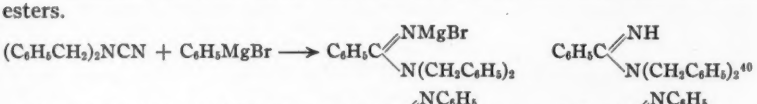
the former being an acid ester is still capable of forming salts[36] and both are ammonolyzed (saponified) to the corresponding acid and alcohol in accordance with the following equations,

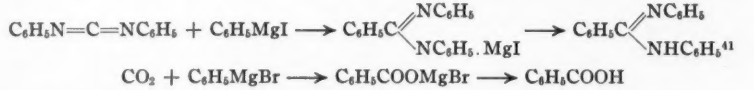
$$C_6H_5N{=}C(NHC_6H_5)_2 + 3NH_3 \longrightarrow HN{=}C(NH_2)_2 + 3C_6H_5NH_2$$

$$NCN(C_2H_5)_2 + 2KNH_2 \longrightarrow K_2NCN + (C_2H_5)_2NH$$

In the first case the reaction takes place on heating with a liquid ammonia solution of ammonium chloride;[30] in the latter by treatment with an ammonia solution of the ammono base, potassium amide.[39]

Finally, the Grignard reagent reacts with the simple ammono carbonic acids to form esters of carbazylic acids just as it reacts with carbonic anhydride to form the carboxylic acids. Two examples, dibenzyl cyanamide and carbo-diphenylimide will serve to illustrate these similarities, since both ammono carbonic esters are converted into ammono benzoic acid esters.





$$CO_2 + C_6H_5MgBr \longrightarrow C_6H_5COOMgBr \longrightarrow C_6H_5COOH$$

Carbonic anammonide, $(C_3N_4)_x$, has been obtained as a highly polymerized orange powder by heating mercuric thiocyanate,[36]

$$2Hg(SCN)_2 \longrightarrow 2HgS + CS_2 + C_3N_4.$$

When dissolved in fused sodium hydroxide, carbonic nitride forms sodium carbonate.[42] By the action of fused sodium amide, disodium cyanamide is formed.

[39] Griswold, Thesis, Stanford University, **1926.**

[40] Adams and Beebe, *J. Am. Chem. Soc.*, **38,** 2769 (1916).

[41] Busch and Hobein, *Ber.*, **40,** 4296 (1907).

[42] King, Thesis, Stanford University, **1924.**

THE PEANUT INDUSTRY. IV. PEANUT OIL*

D. F. J. LYNCH, WASHINGTON, D. C.

The broken pieces of nuts and those shriveled and undersized kernels which pass through the screens in the shelling plants are augmented with moldy nuts and other meats which are considered below grade by the operators at the picking tables to make No. 3 peanuts or the so-called "oil stock" or "mill stock." From the roasters of blanched peanuts and the peanut-butter manufacturers the crushers also receive the brown skins which contain as high as 14% oil and the germs which they add to this oil stock. In 1922 and 1923 most of the crude peanut oil manufactured in the United States came from this "oil stock."[48] In 1921 on the other hand the southeastern crushers, who produce most of our crude peanut oil, found it advantageous to crush most of the Southeastern Runner crop and also a large part of the Spanish peanut crop. Whether the peanut oil produced in this country comes wholly from No. 3 nuts depends on the then existing relationship between the prices of peanut oil, farmers' goods, and shelled peanuts. In other countries, however, the crushing of oil from peanuts is not a subsidiary business dependent on the business trend of the shelling industry, as it is in this country, but is itself a major industry. Such is the status of the peanut oil industry in France.

French Peanut Oil Industry

France is the most important importer of peanuts in the world. Upon this import business, which in 1913 accounted for 177,900 metric tons of unshelled nuts and over 240,000 metric tons of shelled peanuts, there has been built up around Marseilles the large French peanut oil industry.[49] In 1912 Marseilles produced 15,500,000 gallons of edible and about 23,000,000 gallons of inedible peanut oil.[50] Holland and Germany have also developed their own peanut oil industries. Due to the local demand in France, which is more than equal to the supply of first-pressing oil, the large amount of capital tied up in the oil mills, and the possibility of other countries developing their own peanut oil industries, France has been concerned with the future supplies of raw materials for its oil mills. Fortunately for France over one-half of its peanuts are imported from the French West African Colonies, with Senegal shipping 90% of this supply. Production in West Africa is, however, most primitive. With improved methods the production could very probably be greatly increased but lack of an intelligent labor supply, bad transportation, and native customs work against this end. The completion of the Thies-Kayes Railway is, however,

* Part I of this series of articles appeared in THIS JOURNAL, **7**, 794–811 (Apr., 1930); Part II, pp. 1037–50 (May, 1930); Part III, pp. 1277–90 (June, 1930).

[48] *U. S. Dept. Agri. Bull.* No. **1401.**

[49] *B. of Imp. Inst.*, **15**, 576–9.

[50] *U. S. Dept. of Agr. Farmers Bull.* **751.**

expected to increase the Senegal production about 30%.[51] These West African nuts, known as "Rufisque" from the chief peanut-exporting port in West Africa, are shipped in the shell to Marseilles and practically all these shipments can be used for the production of edible oil. Marseilles also receives peanuts from China and India but these are shelled before shipment. The Chinese nuts are shelled almost entirely by hand, are carefully packed so as to avoid being broken or becoming moist in shipment, and are naturally the source of an excellent grade of edible peanut oil. In India much of the peanut crop is grown along the Coromandel coast and is known to the trade as "ordinary Coromandels." Before shipment these are shelled by a very inefficient native method. The pods are covered with water so they can be easily opened when flayed with clubs. Of itself this procedure would not be so bad but the moist kernels are not thoroughly dried before shipment. The moist meats are then carried on a long three-week voyage, much of it through hot regions, and reach Marseilles in a poor condition. The Coromandels cannot therefore be used in the production of edible oil but must be worked up for soap stock. The ship voyage from Senegal is less than one-half that from India and traverses no hot regions and some effort has been made, therefore, to build up a shelling industry in the French West African Colonies. Attempts at pressing in West Africa have proved unsuccessful due to the lack of a market for the by-product cake and the lack of intelligent labor. Such a development as the latter would, of course, be unacceptable to Marseilles. On the other hand, a West African shelling industry would receive support from Marseilles. Since one ton of unshelled peanuts yields only 0.7 ton of meats and occupies the shipping space of 1.6 tons of kernels, the economy in transporting shelled nuts is obvious. Determined efforts are therefore being made in the West African Colonies to overcome native methods and customs in order to erect there an efficient peanut-shelling industry.[51]

Arriving in Marseilles, the unhulled "Rufisque" nuts must be run through the shelling plants because, in France, peanut oil is almost invariably made from shelled peanuts. The inner red skins are also removed as completely as possible and the meats degermed before crushing. The clean meats are now ready to be ground into a meal. This operation is carried out in a machine equipped with a series of corrugated rolls which grind but do not crush the meats. The meal is formed into "cheeses" which are wrapped in hair cloth and piled on one another in the Marseilles press.[50] The pressure applied in this press is not as great as that used in our presses but otherwise the Marseilles press is similar to the American hydraulic press except that it has no sides or "boxes." The "cheeses" or cakes are separated from one another, in the press, by a thin steel plate. When filled the pressure is

[51] *Foreign and Domestic Trade Information Bull.* **322** (1925), C. L. James and W. Frost.

applied and the cakes kept in the press under pressure until about one-half of the oil content of the meal has run out. This oil, known as cold-drawn or virgin oil, is nearly colorless and has a pleasant nutty taste. If the metal of the press is clean and free of rancid nuts the oil needs only filtering to remove fine pieces of peanut meal which may have run out in it. Upon filtering, this oil is available for all edible purposes. This virgin oil is very popular in France and the demand for it surpasses the demand for the best grade of olive oil. When this virgin oil has been drawn off, the pressure is released, the cakes removed from the press, taken out of the wrapping cloths and ground up. At this point some plants add a small amount of water which facilitates the expulsion of the oil in the subsequent pressing. Advocates of adding moisture to the meal at this point say that the material should be exposed to steam or atomized water until a gain in weight of 10–40% results. Then the pressing, either hot or cold, can be efficiently accomplished with one-tenth of the usual pressure.[52] A pressure of 5–10 kilograms per square centimeter, it is claimed, has been found to be sufficient in pressing the oil from peanut meal. The moist ground meal is heated for a short interval, formed again into cakes and again pressed. The oil obtained from this second pressing is, of course, of a quality inferior to that of the virgin oil. Often, however, second runs produce oil good enough to go into low-grade edible oil. A third pressing is often carried out at most oil mills and some plants find that they can make a fourth run with profit. The oil obtained from these later runs are, of course, used for soap-making and other industrial purposes.

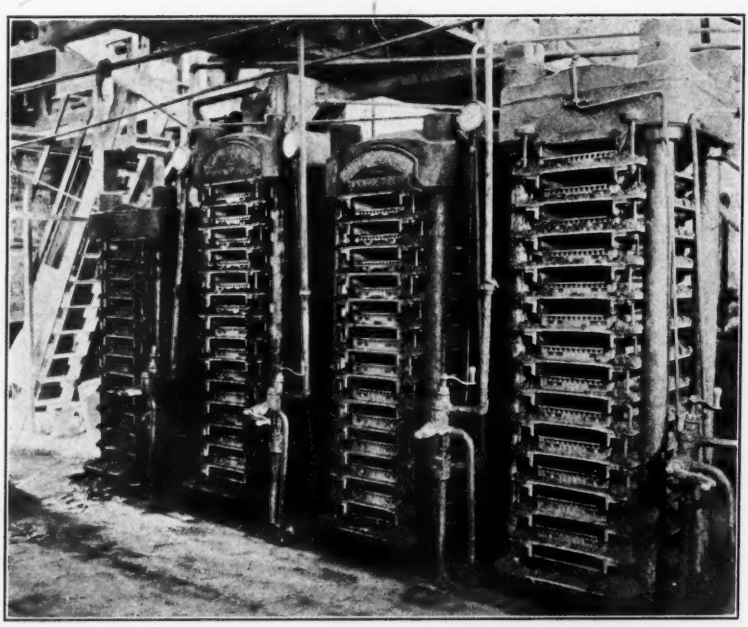
American Peanut Oil Industry

While peanut oil has been for years one of the more important of the world's food oils, it has not been an important food article in this country until comparatively recently. There were imported into the United States for the year ending June 30, 1914, 1,332,108 gallons of peanut oil which was valued at $915,939.[53] About one-half of this volume entered the country through Chicago presumably for use in making oleomargarine. Up to that late date there was no commercial production of this important oil in this country, due no doubt to the disposal of the peanut crop into other channels at prices which an oil crusher could not afford. The world shortage of both animal and vegetable oils created by the World War increased our importation of this oil and helped to start our peanut oil industry. For the calendar year of 1916 we imported 2,089,801 gallons and during the same period manufactured 3,488,649 gallons of peanut oil.

There were also other economic factors which aided in the establishment of our peanut oil industry. From 1900 due to the ever-increasing peanut

[52] Brit. Pat. 179,191.

[53] *U. S. Dept. of Agri. Yearbook*, **1917**, p. 121.



HYDRAULIC PRESSES USED FOR CRUSHING OIL FROM PEANUTS

crop there existed the yearly problem of disposing of that part of the crop that was unfit for use in the peanut roasting, the peanut butter, and the peanut confectionery trades. There existed also at that time in our South large regions seriously infested with boll weevil.[50] Planters there were deprived of their cash cotton crop. In these sections also oil millers had erected plants for the crushing of cotton seed and, for a time, it looked as if some of these oil millers would have no further use for their plants. These farmers turned to the hardy peanut for their cash crop and naturally the oil millers turned their attention to the possibility of crushing peanuts. The grinders, oil presses, filter presses, and conveyor systems already installed in the cotton oil mills can all be used in the crushing of peanuts. The farmers' goods available to these mills had to be first run through the shelling factories. The lack of cleaning and shelling plants in many parts of the South together with the high prices offered for peanut oil in 1917, 1918, and 1919 was, no doubt, the cause of the practice of crushing unshelled peanuts. In 1917 the average price of refined peanut oil in New York rose from 15.26 cents to 21.62 cents. In 1918 an average price of 23.48 cents a pound was paid which in 1919 reached the peak of 24.26

cents.[54] The shortage produced by the war allayed, 1920 saw the break in the price of peanut oil to an average of 12.32 cents. Today the wasteful practice of crushing unhulled peanuts has been discontinued. Not only do the shells add nothing to the value of the cake but they lower the grade of oil produced, as well as absorb a considerable volume of the oil. The larger yield of oil, together with the improved quality, more than pays the small expense of shelling and cleaning the nuts.[48]

The presses used in this country for the production of oil are of two types. The expeller type is a continuously working machine[55] and is fairly effective with unshelled nuts. Generally today the peanuts are shelled. The meats are then, as in the French practice, run through rolls which crush them. If the machinery used is that installed for crushing cottonseed it is necessary to replace some of the smooth rolls with corrugated ones. This rolling helps to open up the oil cells. With the expeller press the meats are only slightly heated in a steam-heated conveyor which carries the meal to the press. With clean sweet meats it is easy to produce an excellent table oil by this method. This oil needs no refining but is only run through a filter press to remove fine particles of meal before being ready for use. While the grade of oil produced by this method is very high, the yield is low. The cake obtained is very fine, having a very high protein content, and is the source of peanut flour. A few years ago several American firms attempted to market a cold-press or virgin peanut oil but without success.[48] There are, however, many people who prefer virgin peanut oil to olive oil and it has been demonstrated to be the more digestible of the two oils.

With the hydraulic press the ground meats upon leaving the rolls are conveyed to the cooker. The object of cooling is to further break up the oil cells. It has been found that the heating of the corrugated rolls during the crushing of the kernels will also facilitate the later expulsion of the oil in the press.[56] From the cooker the meal is conveyed to machines which form it into cakes and wrap it in hair cloth. The cakes are piled in the press and there subjected to a high pressure. It is customary to work with much higher pressures in this country than those used in France. On the other hand it is seldom that over two pressings are made and the usual practice in this country is one pressing. An effective pressing will leave a cake containing only 6 to 9% oil. This cake is ground into a meal and often some ground hulls are added to reduce the protein content to certain standards customary in the cattle feed trade.

Growing Peanuts for Peanut Oil

If a farmer were considering the cultivation of peanuts, he would be

[54] *U. S. Dept. of Agri. Yearbook*, **1927.**
[55] *U. S. Dept. of Agri. Bull.* **1096.**
[56] Brit. Pat. 222,975.

interested in the following tests made by the U. S. Dept. of Agriculture. Clean peanuts were selected from farmers' stock as they arrive at the cleaning and shelling plants, discarding all trash, and these were shelled by hand. The Spanish peanut averaged about 78% meats and the Virginias 71% meats.[50] These results are higher than those obtained in commercial practice. Due to dirt and trash and "pops" in the farmers' stock the shellers are satisfied with 66 to 70% meats from the Spanish nuts and about 60% meats from the Virginias. Many comparable tests have also been made with the different varieties of peanuts to show their respective oil content. L. Rosenthaler found upon comparing a very large number of analyses on all kinds of nuts that the average oil content of all peanuts was 46.68% ($\pm 0.49\%$).[57] In his results the standard deviation was $\pm 0.35\%$ to $\pm 5.04\%$ and the typical oil value 41.64 to 51.72%. H. C. Thompson reports the average percentage of oil in twelve samples of hulled Spanish peanuts to be 52.5% and that for 19 samples of shelled Virginias to be 43.3%.[50] The difference in the oil content in Spanish peanuts grown under different conditions has been found, however, to be as great as the difference found in shipments of different varieties. It can generally be said, however, that the hulled Spanish peanuts will contain 5 to 10% more oil than either shelled Virginias or shelled Southeastern Runners. A bushel of Spanish peanuts in the shell will average thirty pounds in comparison with the average of twenty-two pounds for the other two principal varieties. Taking into consideration the greater weight per bushel, the higher percentage of meats, the higher oil content per pound of meats, and the shorter time necessary for maturing, the Spanish peanut is much more valuable for oil production and the logical choice of the planter if he expects to market his crop through the oil mills. We are informed by the Southern peanut oil crushers that, in actual practice, a ton of Spanish nuts if shelled before crushing should yield 575–600 pounds of prime crude oil and 770–800 pounds of cake containing 46% protein.[48] If crushed with the shells the crushers get 560 pounds of oil and 1300 pounds of 30% protein cake. Southeastern Runners crushed with the shell give 525–560 pounds of crude oil and 1300 pounds of 28% protein cake. There is usually a hundred-pound manufacturing loss per ton in the crushing operation. No. 3 Virginias, which are the only nuts of this variety that are crushed, average about 560 pounds of oil and 1340 pounds of cake. "Oil stock" will, of course, vary greatly in the yield of oil obtained. If composed mainly of stems and shriveled kernels the yield of oil may be as low as 50 pounds per ton but if composed chiefly of slightly damaged shelled Spanish peanuts the crusher may obtain as much as 860 pounds of crude oil and yields of 700 pounds per ton of crude prime oil from this type of "oil stock" is often encountered.

[57] *Arch. Pharm.*, **262**, 25 (1924).

Refining

For some use; *e. g.*, oil in miners' lamps and for soap stock, hot pressed peanut oil needs only to be filtered. For such uses this crude oil is otherwise satisfactory. Peanut oil, like most others oils, for most uses must be refined. Fats are glycerides of oleic, linoleic, palmitic, stearic, and similar acids. The vegetable fats or oils are found in the reproductive organs of plants. To obtain these valuable fats the material is so treated as to disrupt the oil sacs. This may be accomplished by mechanical pressure when the mass is either hot or cold, by rendering the material with heat with or without the addition of water, or by the extraction of the ground mass with a suitable solvent. The extraction of oil with a solvent is attempted generally only when the product is destined for inedible uses. C. F. Eddy[58] treats the press cake with benzene, acetone, or some other volatile fat solvent. The insoluble material is separated from the dissolved fat by centrifuging in the presence of water. Both the liquid and the residue are continuously withdrawn from the centrifuge. The solvent is recovered from the oil by evaporation. Any good solvent extraction method will remove practically all the oil in the cake. The difficulty of the method is to so control operations that loss of valuable solvent by evaporation be kept at a minimum. There exists also, of course, considerable fire hazard in working with large amounts of such highly inflammable liquids.

If the material crushed was clean and fresh the oil obtained will be neutral and sweet. Commercially obtained, however, the oil is usually contaminated and acid. The acidity of oil is a function of time, temperature, and exposure to oxygen and moisture. An increase in acidity of an oil is accompanied with deepening of the color, the appearance of an unpleasant taste and odor, and fine impurities appear floating in the oil. The reclamation of the pure oil from the crude product is known as refining. F. M. Turner[59] and E. Weeker,[60] in their refining methods, treat the oil by injecting into it finely divided water or steam under pressure and claim thereby to effect a distillation of the fatty acids out of the oil. Usually, however, the first step is to neutralize the free fatty acids that are present in the oil. This is done by the addition of some alkali and heating the oil to what the refiners call the "break." The alkali reacts with the fatty acids forming soaps which are called "foots." These "foots" settle to the bottom of the refining kettle. Some refiners add sodium silicate to help in the separation of these soaps. The oil when drawn off is usually cloudy and still contains some color. The next step, called bleaching, is carried out by adding to the hot oil a small amount of Fuller's earth and filtering.

[58] U. S. Pat. 1,607,731.
[59] U. S. Pat. 1,448,581.
[60] U. S. Pat. 1,622,126.

C. H. Hapgood and G. F. Mayno[61] suggest an inversion of these two operations. To the hot crude oil they first add the Fuller's earth, silica gel, diatomaceous earth, or similar decolorizing material and then at a lower temperature add the alkali solution for the neutralization and removal of the free fatty acids.

At this point, however, the colorless oil still retains undesirable odors which are removed by blowing superheated steam through the oil which is kept warm in a vacuum kettle. The resulting product is a colorless, odorless, and nearly tasteless bland peanut oil. Subjected to these same treatments very different crude oils lose nearly all of their characteristic flavors, becoming so bland that the ordinary individual finds it very difficult to differentiate between well-refined corn, cottonseed, olive, and peanut oils.[62] There are some who like an oil for salad and cooking which retains its characteristic fruit or nut taste and, of course, with these people the virgin oils find favor and a bland oil is unacceptable. To impart some taste and odor to refined peanut oil N. Sulzberger has patented a method of impregnating the bland peanut oil with the aromatic constituents of clover and hay.[63] The oil is heated for several hours at 50–60°C. with clover which has been previously dried at 110°C. There has been encountered, however, no commercial use of this method. Most people prefer a bland, nearly tasteless oil and this fact accounts for our oil crushers directing the entire industry toward the production of refined peanut oil.

In the production of this bland peanut oil the chief refining difficulty comes in effecting a sharp "break": *i. e.*, a clean-cut formation and settling out of the "foots" or soaps which are formed, upon the addition of the alkali solution, from the free fatty acids present in the oil. Upon the character of the "foots" formed depends the completeness with which the soaps are removed from the oil, the ease with which this removal is accomplished, and the percentage of oil lost in the operation. If all of the "foots" are removed the keeping quality of peanut oil is very good but oil remaining in contact with these soaps deteriorates.[64] One method proposes the slow addition to the warm oil of only enough 20% solution of sodium hydroxide to neutralize 95% of the free fatty acids. The mixture is then cooled to room temperature at which point the soaps separate out in an easily filterable form. This soap stock contains 25–30% oil which represents a loss of about 3.3% on the basis of the original oil. The refined oil will contain 0.8% free fatty acid but is fit for edible uses.[65] Baskerville has also introduced some changes which he claims effect a sharp "break," a smaller

[61] Brit. Pat. 228,889.
[62] *U. S. Dept. of Agri. Yearbook*, **1917**, p. 298.
[63] U. S. Pat. 1,140,629.
[64] W. F. Baughman and G. S. Jamieson, *J. Oil & Fat Ind.*, **4**, 2241 (1927).
[65] *Chem. Umschau*, **30**, 198–202 (1923).

IMPORTED PEANUT OIL BEING LOADED INTO TANK CARS FROM STORAGE TANKS

refining loss, and deposit the "foots" not in the usual coherent state but rather in a fine porous condition which facilitates the filtering out of these soaps.[66] Baskerville suggests the use of strong sodium hydroxide solution (25° Bé.) and the addition of soda ash to dehydrate the oil, and mixing into the oil 1–2 per cent of short cotton fiber linters. This addition of linters only adds one-quarter of one per cent of cellulose to the soap, and materially improves its filterable condition. P. T. Webster reports that under factory conditions this process gives a better "break," more easily filtered "foots" and a lower refining loss.[67] Depending on the quality of the peanuts from which the oil was obtained the loss in refining crude peanut oil will vary from 4 to 9 per cent. Contracts for the sale of prime crude peanut oil are so drawn that for each per cent loss in the refining over and above the customary 5 per cent loss, one per cent is deduced from the contract price. Peanut oil is usually sold by the carload with the purchaser furnishing the tank car. A tank car will hold 8000 gallons and, since a gallon of peanut oil weighs roughly 7.5 pounds the purchaser is billed for 60,000 pounds of oil.

Peanut Oil Research

In order that the purchaser may utilize this important oil most effectively there must be made, sooner or later, a fundamental study of the oil. From the observing individuals in the trade the public together with the industry learns many facts which are a great advantage but for other facts and for the explanation of observed phenomena we must resort to scientific research. To the long, tedious painstaking efforts of the oil and fat chemists mankind owes much. As stated above the ideal fat or oil is a perfect combination of fatty acids and glycerin so that there will exist in the oil no free fatty acid. Vegetable oils and fats even in their freshest state contain small quantities of free fatty acids. The presence of these free acids is thought to be due to the hydrolyzing or splitting action of certain enzymes which are present in most if not in all oleaginous seeds. Vegetable oil should not be allowed to remain in contact with the organic matter from which it has been obtained because the conditions which there prevail favor the hydrolyzing of the oil. Filtration should be carried out as soon as possible after the pressing, as this operation removes most of the enzymes. Recognizing the importance of this fact the peanut oil producers save the country large amounts of peanut oil daily. Alkali refining, it has been determined, destroys any enzymes not previously removed by filtration and this fact enables those interested to purchase peanut oil in large volumes and keep it for some time in storage with safety.

There has been a large amount of investigational work directed toward the study of this hydrolysis. The progress of the hydrolysis is calculated as

[66] Baskerville, *Chem. Age* (N. Y.), **28,** 342 (Sept., 1920).

[67] *Cotton Oil Press,* **5,** No. 5, 36–8.

acidity and the acidity of vegetable oils, due to trade usage, is expressed in terms of oleic acid. Much interest has been manifested regarding the mechanism of this reaction and whether certain glycerides are more susceptible to this splitting action than others. It can be said that the hydrolysis probably takes place concurrently in three stages so that tri-, di-, and monoglycerides as well as glycerol and free fatty acids may be present in the oil at the same time. As Anton Thurm[68] proved that the free fatty acids present in the mixture existed in the same ratio as the unhydrolyzed glycerides were present in olive and palm oils, so Jamieson and Baughman[69] showed that the fatty acids in peanut oil are set free by hydrolysis in practically the same proportions as they occur as glycerides in the oil.

It was soon recognized that under the same conditions some oils turned rancid quicker than others. Research quickly showed that those fats and oils containing the larger amounts of glycerides of unsaturated fatty acids are the more liable to become rancid because their molecular structures make them more reactive. The more reactive nature of their glycerides accounts for the more rapid absorption of oxygen by these oils with the formation of malodorous compounds.[70] The obvious remedy is to protect the oil from oxygen and moisture. This tendency of an oil to oxidize is roughly determined by its reactivity with iodine and is expressed as the iodine number of the oil.

The scientific study of peanut oil is made extremely difficult because the oily mixture is composed of glycerides of fatty acids, a number of which occur in very small quantities and the acids of these glycerides have very similar physical and chemical characteristics. The isolation and purification of some of the fatty acids now known to occur in peanut oil was only accomplished after long, tedious work. Chemical investigators describe peanut oil as a limpid, light yellowish or straw-colored oil with a faint odor and a bland taste. It is a non-drying oil, becomes turbid at 3°C. and has a specific gravity of 0.916–0.918. It has an iodine number of 93.2 and its saponification number is 185.3.[71]

Three sets of investigators, among others, have carried out noteworthy analytical investigations on the composition of peanut oil. H. Meyer and R. Beer[72] report peanut oil to contain palmitic, oleic, linoleic, lignoceric, and arachidic acids. These chemists did not report any stearic or hypogaeic acid. In 1919, A. Heiduschka and S. Felser[73] reported that peanut oil contained 4.0 per cent palmitic acid; 4.5 per cent stearic acid; 7.4 per

[68] *Z. angew. Chem.*, **1890,** 482.
[69] *Cotton Oil Press,* **7,** 35–6 (1923).
[70] D. Wesson, *Am. Food J.*, **119** (Mar., 1924).
[71] *Z. deut. Oil Fett. Ind.*, **46,** 129 (1926).
[72] *Uni. Prag. Monatsh.*, **34,** 1195, 1208.
[73] *Z. Nahr. Genussm.*, **38,** 241–65 (1919).

cent linoleic acid; 2.3 per cent arachidic acid; 1.9 per cent lignoceric acid, and 79.9 per cent oleic acid. They claim that the oleic acid fraction contains some hypogaeic acid. Jamieson, Baughman, and Brauns[74] report the presence of the following acids in peanut oil.

TABLE I

	Spanish peanut oil	*Virginia peanut oil*
Oleic acid	52.9	60.6
Linoleic acid	24.7	21.6
Palmitic acid	8.2	6.3
Stearic acid	6.2	4.9
Arachidic acid	4.0	3.3
Lignoceric acid	3.1	2.6

These investigators could not detect hypogaeic acid. Hilditch and Vidyarthi[75] in 1927 claim to have identified hypogaeic acid. Heiduschka and Pyriki[76] and Holde and Godbole[77] have reported the isolation of pure lignoceric acid from peanut oil, and the later investigators[78] report the presence of traces of ceratic and hexaconic acids. In their article in 1922 Heiduschka and Felser[79] suggest that the differences in amounts and composition of fatty acids found by the various investigators can be explained by the different sources of the oil samples and are not necessarily experimental errors.

Application of Results of Research

With an extensive knowledge of the fundamental compounds which go to make up this important oil together with the knowledge of the percentages of these compounds in the oil, there have been built up the methods for identifying the oil in foodstuffs. Methods for identifying the various oils find application in the enforcement by the Federal Government of the Pure Food and Drugs Act. In this work the chemist insures the people not only of pure foods but protects them from fraud by substitution on the part of the vendor of a cheaper oil, for example, after he has already advertised his foodstuff to contain a more expensive oil. An idea of the accuracy of this analytical work can be gained by the fact that L. Rosenthaler[80] by microchemical tests has been able to identify as small an amount as 2 milligrams of an oil. And to check the subtle adulterator who substitutes only part of the advertised more expensive oil with some cheaper oil, Jansen and

[74] *J. Am. Chem. Soc.*, **34**, 1372–81 (1921).
[75] *J. Soc. Chem. Ind.*, **46**, 172 (1927).
[76] *Pharm. Zentrabl.*, **66**, 1–3 (1925).
[77] *Ber.*, **59B**, 336–40 (1926).
[78] *Z. deut. Oil-Fat*, **45**, 303–5 (1925).
[79] *Z. Nahr. Genussm.*, **43**, 381–2 (1922).
[80] *Chem. Abstr.*, **15**, 952 (1915).

Schut[81] have developed a method with aniline of identifying mixtures of two and three oils by means of their separation temperatures.

Nutritive Value of Peanut Oil

Another line which chemical research has followed, and one which is of interest to the general public, seeks answers to the questions: Is peanut oil good for human consumption? How does peanut oil compare with other oils as human food? Holmes and Longworthy[82] tell us that with the exception of cocoa butter vegetable oils are as completely utilized in the body as animal fats. With allowance for metabolic products the coefficients of digestibility of vegetable oils range from 97.8 for olive oil to 98.3 for peanut oil. Experiments carried out with human subjects showed that there was actually available to the body as energy 93.9 per cent of the peanut oil consumed and this mark was not surpassed by any other vegetable oil. Injected into the peritoneal cavity E. W. Schwartz[83] showed that peanut oil is harmless and slowly absorbed. With the introduction of hydrogenated or hardened oil the question naturally arose whether these new fats were as digestible. E. Rost[84] found that hardened oils are similar in their physiological action to the unhardened oils and exhibit no harmful properties. They should, of course, contain no nickel or arsenic. (Nickel is the catalyst used in the hydrogenation process.) Holmes and Duel[85] found that the digestibility coefficients of hardened peanut oil decrease slightly with each increase in the melting point of the hardened oil. They also report that all hardened peanut oils melting below 46°C. are well utilized in the human body.

Irradiated Peanut Oil

Any report on the nutritive value of peanut oil would be incomplete without reference to the recent work on irradiation. Pietro Rondani[86] showed that even short exposures of not over one-half an hour to ultraviolet rays increase the antirachitic and calcium-fixing properties in peanut oil. In these experiments carried out on young rats, which were otherwise on a ricket-producing diet, irradiation of the peanut oil promoted maintenance and growth. By color reactions H. V. Euler and his co-workers[87] demonstrated the development of A and 1 D vitamins in peanut oil through irradiation. The feeding of this irradiated peanut oil to young rats in excessive amounts, 80 times the 1 D vitamin requirement, Euler

[81] *Chem. Weekblad*, **23**, 498–502 (1926).
[82] *U. S. Dept. of Agric. Bull.* **505.**
[83] *J. Pharmacol.*, **17**, 115–9.
[84] *Arbl. Reichs Gesund. Amt.*, **52**, 184–209 (1920).
[85] *Am. J. Physiol.*, **54**, 479–88 (1921).
[86] *Sperimentale*, **80**, 443–63 (1920).
[87] *Z. Physiol. Chem.*, **157**, 263–82 (1926).

showed, results in a striking gain in the young animals without noticeable anomalies.[88] In 1925 the same workers[89] made an interesting study of the effect of irradiation. A ration of 20 per cent vitamin-free casein, 50 per cent starch, 15 per cent hardened peanut oil, and 5 per cent McCallum's salt mixture was fed *ad libitum* to young white rats until an equilibrium in weight was established. Then one gram of the substance to be tested was irradiated by a quartz-mercury lamp and administered daily. No further growth was obtained with irradiated water, casein, hardened peanut oil, or stearic acid, whereas growth was resumed by feeding irradiated peanut oil. These scientists concluded therefore that the capacity for activation is probably a function of the unsaturation in the fatty acid.

Possible Future Uses

It is scientific research which also points the way to future uses of our resources. No better example can be given than the large amounts of peanut oil made available today for human consumption through the research on the catalytic hydrogenation of unsaturated oils which was performed twenty years ago. Some of the following reported work may, in like manner, point the way to other uses of peanut oil tomorrow. One method is presented in which the ground peanut meal is extracted with a solvent to remove the fat and then extracted with alcohol. The residue is then treated with a weak alkaline solution to dissolve the protein. This protein solution is then mixed with the residue obtained by evaporating the alcohol extracting solution to dryness and the mixture is emulsified with a fat, preferably the fat removed in the first extraction, to form an artificial milk.[90] S. Spiers and J. L. Bitter[91] suggest the use of the esters of the fatty acids of peanut oil together with 15 per cent free fatty acids for use on combining wool. Due to the scarcity of fuel oils in France the French chemists have directed their work along this line. Tests made with the so-called semi-Diesel engines, whether they be two- or four-stroke cycle type, have proved that peanut oil can be successfully used.[92] Angoulvant found that the consumption of peanut oils, having a calorific value of 8600 calories, is about 240 grams per horsepower hour and recommends its use as a fuel in tropical countries.[93] For use as a fuel oil Alphonse Mailhe suggests the catalytic decomposition of peanut oil by passing it over aluminum or copper mixed with a dehydrating agent or the simultaneous dehydration and cracking of the oil in the presence of zinc and calcium chlo-

[88] *Z. Physiol. Chem.*, **157,** 163–70 (1926).

[89] *Ibid.*, **144,** 123–31 (1925).

[90] K. Erslev, Brit. Pat. 121,133. Also W. J. Melhuish, U. S. Pat. 1,243,855.

[91] *Textile Recorder*, **43,** 68–9 (1926).

[92] R. E. Mathat, *Engineer*, **132,** 138–9 (1921); P. Delahousse, *Chimie et Industrie*, Special No. (May, 1923), p. 764–6.

[93] *Bull. Matieres Grasses*, **1919,** 59–62.

rides mixed with salt. The resulting mixture is composed chiefly of methane and higher hydrocarbons of that series. The liquid hydrocarbons are neutralized and hydrogenated to form a motor oil.[94]

Present Uses

Today, however, the peanut oil supply is consumed in the following industries. The better grades of refined peanut oil are consumed in salad-oil blends and table dressings. Either for making the ordinary French salad dressing or for those types in which the oil is mixed with other ingredients to form a homogeneous emulsion, as in mayonnaise and cooked dressings, tests have proved peanut oil to be very satisfactory. It seems to form a permanent mayonnaise more readily than other salad oils and the dressing will stay smooth and uniform even when the peanut oil is added without the precautions one often finds necessary when using olive oil.[95] The preparation of canned sardines has taken a large amount of refined peanut oil. Due to its stability at high temperatures and the fact that it will not absorb disagreeable odors the customary practice is to cook the sardines in peanut oil which is then drawn off the fish and the fish are then packed in olive oil. The main use for this oil is, however, in the manufacture of oleomargarine. Oleomargarine is produced from various mixtures of the following fats: cottonseed oil, cocoanut oil, neutral lard, oleo oil, peanut oil, and butter fat or cream churned in milk. The trade articles sold under the name nut margarine are made from nut oils. Although botanically the peanut is not a nut, practice has, in this incident, grouped it with the palm nut and the cocoanut. Actually, very little palm nut oil is used in this preparation, practically the whole production depending on the supply of cocoanut and peanut oils. Although nut margarine may contain no oleo, to comply with the law it must be labeled "oleomargarine." Until the commercial introduction of the catalytic process for the hydrogenation or hardening of oil, the large demand for shortening for cooking had to be taken care of by lard. Shortening or lard compounds are composed of a mixture of cottonseed oil, corn oil, soy-bean oil, and peanut oil blended with enough oleostearin from beef fat or neutral lard to give a sufficiently hard, firm product when chilled on a "lard roll." Today hardened vegetable oils can be produced at a price which allows the manufacturer to substitute this "artificial stearin" (hardened vegetable oils) for oleostearin and some of the trade articles contain no animal fat whatever. The manufacture of shortening and lard compounds now demands large amounts of both hardened peanut and refined peanut oils. That part of the peanut oil production which remains—the inedible oil—finds ready use in the manufacture of toilet soaps.

[94] *J. Usines Gaz.*, **46**, 289–92 (1922); *Compt. rend.*, **177**, 329–31 (1924); *Chaleur & Industrie*, **3**, 1144–6 (1922); *Bull. soc. chim.*, **31**, 567–70.

[95] *U. S. Dept. of Agri. Yearbook*, **1917**, p. 299.

PRINTING PROCESSES. III. RELIEF PRINTING*

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The relief printing surface is similar in principle to that of a rubber stamp. The surface has depressions in it, to be sure, so that it looks like a surface for printing engravings, but that is as far as the similarity goes, for the ink is not a fluid one and does not get down into the crevices. It adheres to the elevated surfaces only.

Woodcuts

A specially prepared wood, usually boxwood from Turkey, valuable for its evenness of grain and ability to take a high polish, is cut into convenient lengths. Next, one side, across the grain, is highly polished and buffed with zinc oxide, known to the artist as "Chinese white." The required sketch or drawing is traced on thin paper, reversed, and placed in intimate contact with this polished surface, and the sketch traced through the paper onto the wood by means of a sharp-pointed stylus. The most difficult feat now follows in cutting away the remainder of the surface, leaving the design in relief, as the printing surface. This is usually done by a machine.

In the printing of woodcuts, the block is inked and that ink is transferred directly to paper by pressure. This is especially true in art work where a very limited edition is wanted, for printing a few hundred copies by this process might ruin the wooden surface. Metal duplicates of this wooden surface are therefore made as electrotypes, by a process discussed later. In colored woodcuts, always associated in the home with etchings, separate blocks are made for each color desired, and each printed in perfect register over the same surface of the paper. This is of course analogous to a method of color printing certain cloths by hand.

Printing from Type

Hand Setting of Type.—The principle of this is so simple that we need only mention that pieces of metal containing the characters in relief on the end, are assembled in their proper sequence by hand, clamped in a frame and inked with a typical printing ink. The ink adhering to the elevations on the type is transferred to paper by pressure. The type is essentially a lead-tin-antimony alloy, the antimony adding hardness to the alloy and also causing it to expand on cooling. This means that when the type was originally formed by pouring the molten alloy into molds, each character would have well-defined and sharp edges. Some common formulas are:

* This is the last of a series of articles which has been appearing in THIS JOURNAL. For Part I, see 7, 1028–36 (May, 1930); Part II, 7, 1263–76 (June, 1930).

PER CENT BY WEIGHT

	Pb	Sb	Sn	Cu
(1)	60	30	10	
(2)	70	18	10	2
(3)	77.5	16	6.5	
(4)	82	15	3	

Linotype.—This machine, perfected by Mergenthaler, is the oldest type-setting machine, but still is one of the most popular. It casts the metal in lines of type, called "slugs," rather than in the individual characters.

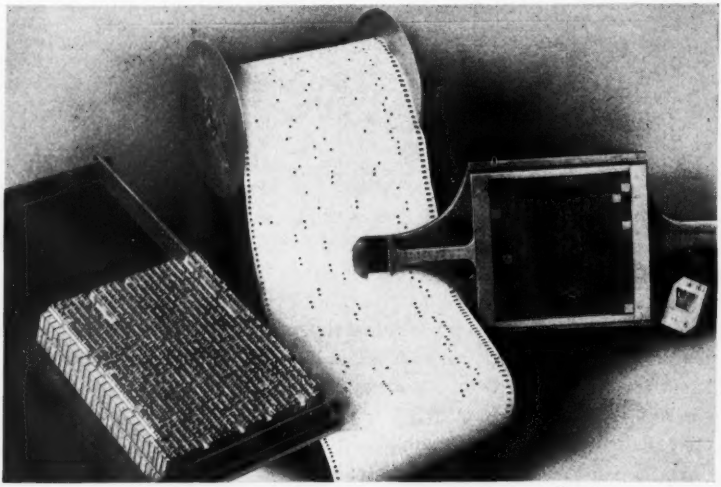
The operator works a keyboard like that of a typewriter. The pressing of a key, however, releases a brass matrix carrying that letter on the edge. The matrices, sufficient to make a single line of type, are carried mechanically in the order keyed, to a place where the operator can inspect the line for errors, rearranging the matrices by hand, if necessary. Then these matrices are inserted into a mold, into which the molten type metal is forced, also mechanically. The metal in the mold solidifies almost instantly, forming the slug, which then passes between knives which accurately cut it down to the desired thickness.

In the meanwhile, the matrices, by very ingenious devices are returned to their origin, to be used over and over again. It is not uncommon to find three different lines of type being made on the same machine at the same time. The matrices for one line may be collecting at the same time that the slug of the preceding line is being molded, while matrices for a still earlier line are being redistributed. The slugs, after being used, are thrown into the heated melting pot, to be used over and over again. The composition of linotype metal is usually practically the eutectic for these

	Pb	Sn	Sb
(1)	84.5	13.5	2
or			
(2)	82	13	5

three components giving an alloy of melting point of 240°C.

Monotype.—This process needs two machines, one of them being a perforating machine, also worked by a keyboard, but which permits the operator to perforate a roll of paper, about 5 inches in width, in such a way that the position on the roll indicates the letter type. That roll is of course analogous to the perforated roll used in player pianos. This roll is later run through the second machine, where, due to the air pressure through the perforations, molten type metal is forced into a particular spot in a mold, again a matrix of the letter to be typed. The metal instantly solidifies, leaving the desired character in relief on its base, making the type in other words. Then the machine arranges these in proper sequence



Courtesy
Commercial Engraving Publishing Co.

FIGURE 12.—SOME SPECIAL FEATURES OF THE MONOTYPE SYSTEM

The spool of paper ribbon, the matrix case, a matrix as used for casting display letters, etc., and monotype cast type.

with reference to the copy and thus a line of individual characters is made. (See Figure 12.) Since the line of type is not a single slug as in the linotype process the operator can correct the line after the type has been made. The metal used here is identical with linotype metal.

A Newer Process.—Without going into detail, I merely want to mention that even the mechanical printing processes have gone "talkie" too, for there is now a machine in which the keyboard has been done away with, and the operator merely spells the words into the receiver and the machine delivers the type.

Duplicates

Very frequently the type set by hand or by machine, or the metal cuts, are not intended to be used on the press at all. Since type metal is a relatively soft metal, the sharp edges of the printing surface would wear away on a long run and the lines of a cut widen, distorting the image. That would mean, in the case of type, that the copy would have to be reset and proof-read again. Rather than do this, duplicates of the original are usually made either as electrotypes or stereotypes. Since innumerable duplicates can be made from one form, these can be printed on different presses simultaneously. In the second place proof will have to be read only on the original. Thirdly, these will be facsimile duplicates, not only as to

subject matter, but even as to exact spacing of letters, etc. These processes work quite well with any type of relief printing surface.

Electrotypes.—For relatively coarse work wax is used as the duplicating medium, while for very fine work, resulting from the proper use of a fine halftone screen, lead is employed.

The wax, usually beeswax or ozokerite, is poured into molds and permitted to solidify in slabs of the proper thickness. This solid wax is placed in intimate contact with the type, clamped in a form and both placed in a press operated by hand, steam, electric, or hydraulic power. (See Figure 13.)

The wax form is then removed and given a very thin film of graphite or "black lead" as it is called in the industry. This is to make the mold a conductor of electricity, for it is to be made cathode in an acidified copper sulfate bath, the anode being a bar of pure copper. The reaction is, of course, the well-known one used in the purification of blister copper and in other forms of copper plating. The copper at the anode is dissolved at the same time that an equal quantity is plated out on the graphite surface of the mold. This plated film must be a tightly adhering, fine-grained, bright copper surface, which means that proper control of the concentrations, temperature, and current density must be maintained. After this deposit is thick enough, taking one to eight hours for its formation, the cathode is removed and hot water is poured on the mold, permitting the copper deposit to be safely removed. Of course this thin copper film is not strong enough to be put on the press, so it is backed by more metal. The customary procedure is to place a sheet of tin foil on the reverse of the form and then heat sufficiently to cause the tin to alloy with the copper. Then molten type metal is poured on the tin and allowed to cool, after which it is shaved down to the desired thickness and mounted on wood, thus forming the duplicate printing surface. On account of the fact that the copper printing surface is harder than the original type metal, longer runs can be made. (See Figure 14.)

Courtesy Commercial Engraving Publishing Co.

FIGURE 13.—THE IMPRESSION AS MADE ON THE WAX CASE

Lead Molds.—Where lead is used in making the duplicates, especially in very fine work, a sheet of lead about 1.5 mm. thick is placed on the type

or cut and enormous pressures applied. Then copper is electroplated, as mentioned in the wax process, except that, of course, the use of the graphite conducting film is unnecessary. This copper deposit is also backed with type metal.

Nickel Types.—The wax or lead form is given a flash coat of copper and the plating continued in a nickel bath. These duplicates are less affected by certain kinds of ink and wear better on the press, it is claimed. The sulfide of certain pigments, like ultramarine blue and vermilion, might tarnish a copper plate, but probably would not injure the plate seriously.

Aluminotypes.—These are made by making a mold in plaster of Paris, and after it has set filling with a hard aluminum-copper alloy. This form need not be backed for it is made thick enough and strong enough to be put on the press after being shaved down to the necessary thickness. These

Courtesy
Commercial Engraving Publishing Co.

FIGURE 14.—BACKING UP THE SHELL

are made only in special work and hardly ever when the work is the result of a halftone screen finer than 133 lines per inch.

Stereotypes.—The stereotype process is a relatively inexpensive method of making duplicate plates, doing very satisfactory work with type or coarse halftones. The matrix is made of *papier mâché* or paper pulp, or it is built up of layers of wet tissue paper cemented together with a special paste. This wet paper is placed on the metal surface to be duplicated, covered with a blanket and pressure applied by beating with a stiff backed brush or by carefully rolling. Then the matrix with its metal form is heated, dried, and the paper carefully removed. In the reverse of this form is poured the molten type metal, which when solidified becomes the printing surface.

This process has a very decided advantage in newspaper work, where paper matrices can be sent by mail from one city to another with a minimum of postage.

Photomechanical Processes

Zinc Line Cuts.—Let us see how the illustration of the halftone screen (Figure 8, p. 1269 of June JOURNAL) was reproduced. The original was a pen and ink drawing, in black on white, with no shades of grey or any other colors. This is the type of material reproduced by zinc cuts.

The original drawing, four or five times the diameter of the printed one, was photographed in such a way that the image on the photographic plate was the exact size wanted on the printed page. This photographic plate, usually a wet plate, as mentioned earlier, was developed in the usual manner and the silver-gelatin film stripped off the glass plate and reversed on to another piece of glass. In the particular case that we are discussing this reversing was unnecessary, for there is no top or bottom, no right or left to the sketch, but it would have been absolutely necessary in case some printed matter was involved. Unless it was reversed by a prism in the camera it would have to be done mechanically to keep the words from reading from right to left.

A zinc plate, about 1.5 mm. thick, is carefully cleaned and coated on one side with the bichromate-glue solution which is then allowed to dry. The image side of the glass plate is put in immediate contact with the sensitive side of the zinc plate and exposed to light. As is true in other bichromate processes, the light hardens the hydrogel, making it insoluble. This takes place only through the cleared areas of the negative.

If the zinc plate is now placed in water, the unexposed parts will wash away, leaving only the hardened film adhering in the areas which were exposed to light. The plate is then heated, which carbonizes the hardened gelatin, making a still better "acid-resist." Then the plate is given a flat etch with nitric acid, washed, and dried. Very carefully, "Dragons blood," a reddish resin formed by certain palms, is brushed over the plate, the brush always being moved in the same direction. The plate is rotated 90° and given a second brushing in the same way. Upon heating, this resin adheres to the sides of the pits formed during the first etch and protects the walls from further etching. This is the procedure used previous to each "bite."

Of course during this etching process the back and the edges of the plate are "stopped out" with an acid-proof "resist." The same is applied to large areas to be etched, for they are stopped out and the zinc is removed later, mechanically, by cutting away the surface or "routing out" the zinc as the technical expression has it. This mechanical cutting away of the zinc is merely to save time and etching solution.

The plate is then dried and "routed," having large areas cut away by a bit on a spindle spinning ten to twenty thousand revolutions per minute. After being backed with wood it is now ready for the press.

Although zinc is generally used, copper is sometimes substituted, for it permits of nicer work and finer lines, although it etches more slowly and costs more. Needless to say, from this zinc cut, many duplicate plates can be made as electrotypes or stereotypes.

Color Plates.—Suppose we want to reproduce the halftone screen (Figure 8) in two colors, say red and yellow. The original sketch would still be drawn in black and white, but the printer would be told that the job was to consist in printing small yellow squares on a red background. The original sketch would be photographed as mentioned previously. Then two separate exposures would be made on separate sensitized zinc plates, and the portions not to be printed with that particular ink stopped out before etching. Or two separate drawings would be made exactly to scale, one showing the part to be printed red and the other yellow, and each photographed and used for the proper ink. Printing consecutively from one plate with one colored ink and then with the other, on the same area and in perfect register, would give us the two-color print.

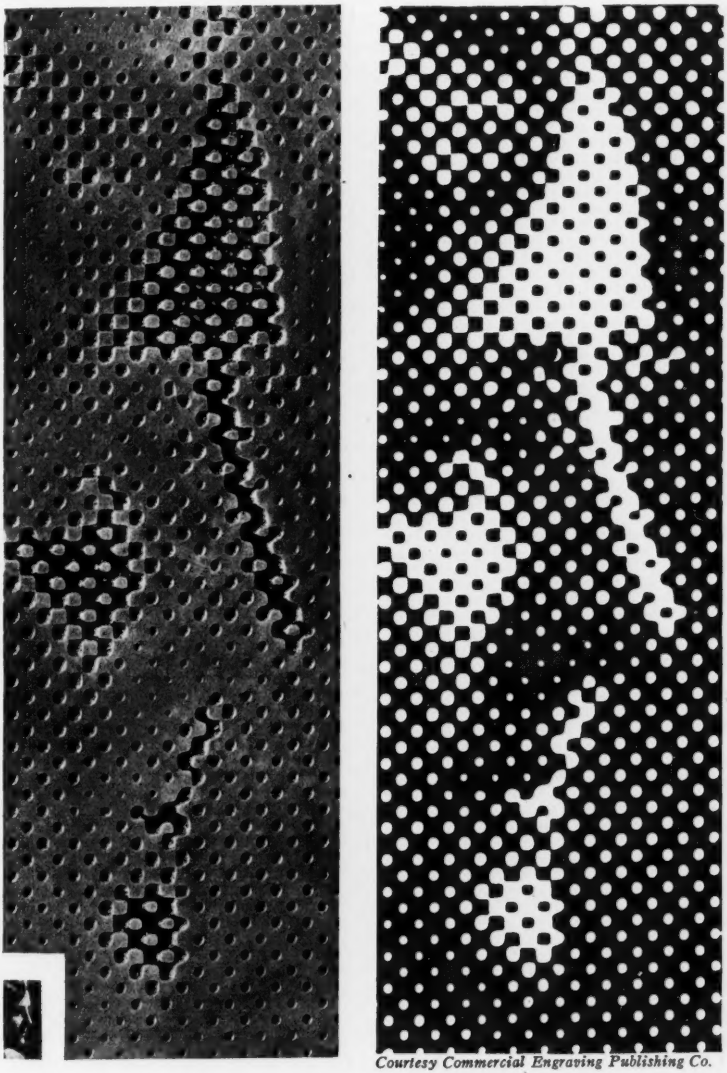
This process would of course give only solid colors, with no shades or tones, if it were not for a relatively simple machine which breaks up large areas of printing surface into small dots. This is called the "Ben Day" machine after its inventor.

"Ben Day" Screen.—This screen is used in a great many printing operations, where it is used for the same purpose. Each screen consists of a transparent film having a smooth upper surface but having the reverse engraved in different designs, such as small dots regularly placed, small dots unsymmetrically placed, herringbone lines, fine parallel lines, etc. The bottom side is carefully inked and by means of a stylus or roller that ink is transferred to the exact area on the metal plate. Dragons blood is added to the wet ink and baked on the surface of the metal, forming in certain areas a coating capable of resisting the action of the etching solution.

The plate now has large areas broken up into smaller printing surfaces, which, even if printed with red ink, will look pink due to admixture with the white of the paper. Sometimes the "Ben Day" screen ink is applied directly to the original sketch, previous to the design being photographed, accomplishing the same end results.

An example of color print made with such screens is the comic section of the Sunday paper, although from an artistic viewpoint the finished print leaves a great deal to be desired, due to inaccuracy of register. See how many different screens you can recognize on a single sheet.

Halftones.—The subject, this time almost anything, is photographed using a halftone screen similar to the one mentioned under lithography (not the rotogravure one) in the camera. Again a wet plate is used, and after proper exposure the plate is developed, backed by collodion, and stripped



Courtesy Commercial Engraving Publishing Co.

FIGURE 15.—THE PRINTING SURFACE OF A SMALL HALFTONE (*Lower Left*) AS IT WOULD APPEAR WHEN GREATLY ENLARGED (*Left*), AND A PRINT (*Right*) FROM THE ENLARGED PLATE

from the glass. This reversed image is put on another piece of glass. This plate is put in contact with the bichromate-gelatin side of a polished copper plate and exposed to light. After washing to remove the soluble colloid, the surface is etched in a ferric chloride solution, where the unprotected copper goes into solution. Of course the back and the edges of the plate have been painted with asphaltum to prevent an unwanted etching there. "Dragons blood" is used as mentioned previously.

The halftone screen accomplishes the result mentioned earlier, for on inspection of the halftone negative it is noticed that it is not a continuous-tone negative, but one actually made up of millions of small areas of varying diameters. The copper halftone cut made from this negative will show these small areas as printing surfaces of different dimensions. (See Figure 15.)

In case work on many presses is desired, duplicate plates can be made by the methods mentioned earlier.

Color Halftone Process Work.—Here the process is exactly like the one outlined under color photolithography (pp. 1271–3 of June JOURNAL) up to the place where the image is put on the plate. Each halftone separation negative is used in making a halftone copper cut as outlined above. Of course there is a different copper cut for each colored ink to be used. So the ink is printed, and when it is dry, another colored ink is added from another plate, always in perfect register. Some presses have facilities for heating the paper and ink after each printing to increase the rate of drying, so that four colors can be printed on the same press. If the screen used in making the halftone was very fine, only about 15,000 copies can be made, while for coarse or medium screen or line, a run of 100,000 copies is not uncommon. The common screens employed have 133 to 150 lines per inch, and down. As was mentioned, nickeltypes give longer runs, while chromium-plated electrotypes may give as many as one-half million good impressions.

Of course stereotypes and electrotypes of these halftone cuts can be made. Such is certainly necessary in the printing of enormous editions. Recently *Time* stated these facts as to the *Saturday Evening Post:*[5]

> There were 2,977,500 copies. Each copy weighed 1 lb., 14 oz. Its 272 pages, containing 275,000 words of editorial matter comprised 295 1/6 sq. ft., enough to paper the ceiling of a room 24 1/2 ft. × 12 ft. An average reader (225 words per minute) would take 20 hr., 20 min., to peruse it. Sixty 45-ton presses, working night and day shifts, printed it in three weeks. . . At an average of $9000 per page, the advertising revenue was approximately $1,512,000. The issue consumed 3000 tons of paper, 60 tons of ink.

Ink

Again let me refer you to that excellent book on "Printing Ink" by Wiborg,[6] where you will find very fine discussions as to the composition of

[5] Issue of Dec. 7, 1929.

[6] Harper & Bros., New York City, 1926, 199 pp.

inks, their particular properties, uses, etc. It also contains a valuable bibliography on ink and printing processes in general.

Additional References

Additional works which can be read with a great deal of profit are:

SIGMUND LEHNER, "Ink Manufacture," Scott, Greenwood & Son, London, **1914.**

DAVID N. CARVALHO, "Forty Centuries of Ink," Banks Law Pub. Co., New York City, **1904.**

NORMAN UNDERWOOD, "Chemistry and Technology of Printing Inks," D. Van Nostrand Co., New York City, **1915.**

C. A. MITCHELL AND T. C. HEPWORTH, "Inks, Their Composition and Manufacture," Chas. Griffin & Co., London, **1924.**

Bacteriophage Not Organism, Says Bacteriologist. "A systematic study of the properties of bacteriophage failed to substantiate its living nature," stated Dr. J. Bronfenbrenner, professor of bacteriology at the Washington University School of Medicine, in an address before the recent meeting at Ames, Iowa, of the Society of American Bacteriologists. The evidence seems to indicate that the bacteriophage is an inanimate chemical product of bacterial metabolism, having no cell-dissolving properties of its own.

Bacteriophage has been hailed as a most potent germ-killer, being made itself from germs, but ever since its discovery by Dr. F. d'Herelle it has been a subject of scientific controversy.

"It seems to exhibit a stimulating effect on homologous or closely related bacterial species. As a result, the rate of intracellular metabolism is abnormally increased with a consequent increase in osmotic pressure within the cell, and if water is available in the surrounding medium, bacteria take it up, swell, and finally burst."

The activity of the phage in suppressing the effects on animal tissue of a definite germ without harming the tissue was compared with activity of certain chemicals. The phage was active at a much wider range of dilutions than any of the five chemicals, mercuric chloride, phenol, formalin, tincture of iodine and chloramine, John E. Walker of the research laboratories of E. R. Squibb and Sons reported. This phage was active at dilutions ranging from full strength to a dilution of 1 to 512, while the nearest chemical, mercuric chloride, could only be diluted to one-sixteenth of the strength causing tissue destruction and still be active.—*Science Service*

Philosophy Needed to Solve Teachers Problems. Educators should not be fetish worshipers, faithfully applying, like charms, the bits of scientific knowledge discovered for their use. They should link philosophy to science. Thus Dr. Truman L. Kelley, vice-president of the section of educators at the Des Moines meeting of the American Association for the Advancement of Science, emphasized the great need for a finer philosophical attitude toward education as science brings new tools to the hands of teachers. Dr. Kelly discussed particularly the danger of depending arbitrarily on psychological tests, now widely used in schools to appraise the abilities and progress of young students.

The test score is never a substitute for judgment; it is merely an aid in making judgments, he emphasized. The rôle of science is to furnish permanent solutions to specific problems. Philosophy is needed to fit this knowledge into the immediate situations which the teacher must face, for in such situations there are always many factors not accounted for by scientific investigations.—*Science Service*

TRADITION VERSUS EFFECTIVENESS

HENRY J. LONG, GREENVILLE COLLEGE, GREENVILLE, ILLINOIS

For a number of years the writer, with many other chemistry teachers, has felt that the laboratory work in general chemistry has had a low efficiency, judged by its teaching value. It is a deplorable fact that in an average class the good student can do the most of the thinking for the poor one. The latter may never learn more than to stumble step by step through a procedure as he would read and follow a recipe from a cook book. The incident of a student in a certain university accidentally turning in a notebook of a previous year instead of her own is a clear illustration of the fact that there often is not as great originality in writing experiments as is desired and that a notebook may teach more penmanship than chemistry.

Words are almost too weak to describe the listless, unconcerned, helpless, "don't care" attitude of an uncomfortably large per cent of beginning students. What general chemistry teacher is not familiar with the student viewpoint suggested by the following? If the student decides to hasten the process of weighing with the more delicate balance by picking up the weights with his fingers, he seems to consider that if the weights do happen to become corroded there is no way of discovering who did it in such a large group. And no doubt there are others who do it, too. If, in weighing a sample on the pans of a rough balance, a part of the substance rolls off the paper to the shelf or floor, what does it matter? The balance pan is entirely too narrow, anyway, Or, if the test tube breaks and the contents spill over the table top, why worry? Isn't it the janitor's job to look after such things? In case the glass stopper of the reagent bottle happens to be a little tight, instead of learning how to coax it out carefully, it is struck with an iron ring and broken off. But no bottle in such a condition should have been upon the shelves. And if he carelessly spills a few drops of hot, concentrated sulfuric acid on his neighbor's sleeve, or his instructor's laboratory coat, he glances up with a sort of apologetic air, as much as to say, "That is all right, I didn't need it anyway for we have plenty more."

These, and an almost infinite number of equally wooden actions of elementary students, nearly cause an instructor to utterly doubt his ability to teach proper attitudes or to develop the scientific mind and viewpoint. It is with the thought of trying to arouse this too large percentage of students from their somnambulistic tendencies, and to make the laboratory work more than a "cook book" and "copy book" exercise, that in Greenville College we are attempting a somewhat revolutionary experiment. It seems that since the days of phlogiston, chemistry experiments had to be formally written in order to constitute creditable work. But the fact that it has always been done that way is not sufficient justifi-

cation for its continuance. Why write them if the energy required therein, expended elsewhere, would have a greater teaching value?

Instead of requiring a formally written notebook in the usual way, we decided to give a quiz on the day's experiments at the end of each laboratory period. It should be stated that we claim no originality in the matter of the quiz at the end of the laboratory period on the day's work, for it has been used, to some extent at least, in organic chemistry classes at the University of Kansas. The students are left at liberty to make their own notations and equations in the blank spaces and pages of their books, which they freely do in order to get the information which they themselves want. Since we are using a combined text and laboratory book, it is easier to correlate the two phases of the course. At first it seemed likely that we could not expect quite as much work to be done as before, if the students were required to have it prepared for a quiz inside of the one, two-hour laboratory period. This, however, does not seem to be true, for the extra urge of being held immediately accountable for the facts studied appears to rather quicken muscles and intellect alike.

If the confidence of the students is kept by carefully making the assignment of such a length that they can adequately cover it in the required time, they all seem to recognize a definite goal toward which they are working in a particular laboratory period. In order to save time and energy for student and instructor, the new type of quiz is used. From ten to twenty specific and representative questions are given which may be answered quickly in one or two words or formulas. The student numbers the questions and, of course, writes nothing except the answer. The name of the student is signed and the papers are exchanged between the members of the class. The person receiving the paper now writes "Graded by John Doe" across the bottom of the paper, and draws a circle around it so it can be seen readily. The fact that a student signs his name as having graded a particular paper seems to make him quite conscientious in grading it accurately. The answers are then quickly read by the instructor and checked by the student and the papers graded. The papers are collected and may be roughly checked over by the instructor if desired. This entire exercise can be taken care of inside of ten or fifteen minutes at the end of the laboratory period.

The following is a list of typical questions on the topic of "Hydrogen Sulfide and Its Salts," ten or fifteen of which will fairly adequately cover the subject, and can be given in the time allotted:

1. In our laboratory preparation of hydrogen sulfide, write formulas of the two substances used in the generator. (FeS, HCl)
2. Give formulas of the substances produced. ($FeCl_2$, H_2S)
3. Give the color of hydrogen sulfide. (Colorless)
4. Is hydrogen sulfide appreciably soluble in water? (Yes)

5. Is hydrogen sulfide lighter or heavier than air? (Heavier)
6. Does hydrogen sulfide have any odor? (Yes)
7. Is hydrogen sulfide acidic or basic in properties? (Acidic)
8. In general, to what group of compounds would you add any reasonably strong acid to produce hydrogen sulfide? (Sulfides)
9. Whenever silverware turns black it constitutes a test for what element? (Sulfur) Or, a fruit jar rubber was found in contact with a silver knife on which was a circular black ring. This shows the presence of what element in the ring? (Sulfur)
10. A paper moistened with a solution of a soluble lead salt on exposure to an unknown gas turned black. What was the gas? (H_2S)
11. In the burning of hydrogen sulfide what product may be obtained which is a gas at room temperature? (Sulfur dioxide)
12. In burning hydrogen sulfide, what product may be obtained which is a solid at room temperature? (Sulfur)
13. In burning hydrogen sulfide what product is formed which is a liquid at room temperature? (Water)
14. When hydrogen sulfide is bubbled into a blue vitriol solution, give the formula of the precipitate. (CuS)
15. What color is the precipitate in No. 14? (Black)
16. What color is zinc sulfide? (White)
17. What color is cadmium sulfide? (Yellow)
18. Is a water solution of hydrogen sulfide highly or slightly ionized? (Slightly)
19. Is hydrogen sulfide a good reducing or oxidizing agent? (Reducing)
20. What is the valence of S in the sulfides? (Negative two)

The above procedure has been tried for approximately a year now on two different classes of general chemistry students of about thirty-five or forty in each class; the laboratory group, itself, consisting of approximately twenty students. It is early to predict all the results, either good or bad, as compared with the former method. It is very refreshing, however, to note how spontaneously the students come to their instructors with their questions. Where formerly only that small group of questioners would venture unless strongly urged to do so, now nearly all seem to feel some impetus to come. The students, themselves, state freely that they are learning more during their laboratory period than formerly. The fact that both groups were started for a few weeks following the usual plan, gave them some basis for comparison. It is our opinion, also, that the grades from the examinations on the textbook work as a whole are being decidedly benefited by such a method. While it means somewhat more work at the time for the instructor, yet this is offset by the fact that the tedious reading of a formal notebook on week-ends is decreased to a delightful minimum.

Mercury Production in the Bogojno district of Jugoslavia has been begun by a Polish group. Up to now, two chamber ovens have been put into operation, eight tons of ore being worked up daily. It is hoped to bring others into operation in the near future.—*Chem. Age*

A PLEA FOR MERCY

EDWIN L. ROE, LASH SENIOR HIGH SCHOOL, ZANESVILLE, OHIO

In common with many other teachers of high-school chemistry I find myself reading with great interest, but with some feeling of guilt, the numerous articles in your valuable magazine concerning the objectives of the high-school chemistry course. The feeling of interest is quite natural as we strive by our reading to improve ourselves in the art or science of teaching our particular subject and so place ourselves in better position to put our message across to the student. The feeling of guilt comes as we realize our inability to nearly reach those splendid objectives and high standards so thoughtfully established for us. Certainly as the high-school teacher looks back over the year and considers the case of any individual pupil, he cannot help but feel that that individual is far from having come up to the desired standard and, despite the fact that the student may have made a good grade in the course, he is woefully lacking in chemical knowledge and that he, the teacher, must be in some measure a failure for not having put the subject across.

But is the teacher entirely to blame in a situation of this kind and is he a complete failure? Is there not a chance that the standards themselves are almost impossible of accomplishment and stand in need of some slight revision? Too often the so-called standards are the work of the teachers of college chemistry or of graduate students in education or science presenting an alleged standard as a part of a thesis for an advanced degree. Usually the person, or persons, presenting a standard have never spent a day in teaching high-school chemistry, have no conception of the high-school mind or of the problems of high-school instruction. The emphasis placed on most standards is that of the college and on those things which the college has decided that the college ought to demand of the high-school graduate in chemistry. With this fact in mind let us see why so many college-bred standards are unacceptable to the high-school teacher.

In the first place there is the high-school student himself. At the age of sixteen or seventeen he comes into contact with chemistry, making for him, in many cases, his first contact with real science. For his general science, a hodgepodge of consistently unrelated facts gleaned from a dozen scientific fields and assembled by a physicist, chemist, biologist, or astronomer [for, as yet, we have no "general scientist"], is often worse than no science at all in so far as the orderly, related, and systematic thinking so essential to all true scientific progress is concerned. The student's knowledge of the world is general and the chemical world in particular is infinitesimal and distorted. He has always taken, as do many adults, the manifest gifts of man and nature as his just due and has never stopped to marvel about their source. Cotton, silk and linen, iron, copper and lead, bread, meat, and the thousand of varieties of prepared breakfast foods are something coming from a store but back of that point he is very much in doubt.

The conception of an orderly universe with its atoms and molecules, molded and formed by the guiding hand of the chemist into the million and one articles at his beck and call, is, to him, a closed book.

"Not to all your students," you may say, "are these things a closed book." True, but I am talking now about the average student who comes to us with no particular aptitude or interest for scientific things. And, Mr. Standard Maker, consider on these things and on this material delivered into our hands and do not condemn us too harshly if our finished product seems unable to remember the law of Gay-Lussac or gets a bit confused about allotropy.

Of course no one will deny that we should have some sort of standards, but it is my contention that as high-school teachers our first and primary duty is to awaken a sense of appreciation of the past achievements of science, offer a glimpse of some of the things we hope that it may do in the future, create a sense of appreciation of its orderliness and beauty and build within our student that type of mind which can truly grasp and appreciate the accuracy of scientific reasoning. We must point out to our youth that the heroes and benefactors of mankind are not all met on the pages of the history text nor that everything that is worth reading has been set down on the pages of the "classics." When we have done these things we may be able to teach a few chemical facts but, after all, this is a matter easily taken care of by those who take our students from our hands.

To do our duty for our students we must never lose sight of the fact that preparing them for college is not the sole, or even the most important, object of our work. Only a small percentage of our graduates will go to college and of these only a few will take more chemistry. The majority of the students will finish their formal schooling when the doors of the high school close upon them at the end of their senior year. It is this big group that we must consider and to them we must give the things that are most likely to prove of lasting intellectual and social worth. What good will it do a girl who enters an office as a stenographer if she can test for the bromine ion but does not know the source of the beautiful dyes which color her dress or that of the rayon fiber of which it is made? Far better for her if she has a broad view of the science of chemistry as a whole and a real and active appreciation of the part chemistry is playing in making her world a more efficient and happier place. Nine months is all too short a time to do more than outline the field of chemistry and to place the student's feet more or less firmly on the edge of that field, but yet to place them in such a way that if the natural aptitudes and inclinations of the student incline in that direction he is in a position to go on and in an orderly, systematic manner make the field his own either by continuing his chemistry in college or technical school or, if his schooling goes no farther, by

the reading and study of popular scientific literature, an immense amount of which is now available for the interested person. Of course the student whose chemistry ends with one year of high-school chemistry will never become a highly expert chemist or chemical authority, or is it necessary that he should. To him a knowledge of chemistry is merely one of those things that he should have to get the best from life and be a cultured and intelligent being. Laws and theories must all be subordinated to the essential facts of things as they are and even then we must glean those facts which are likely to prove of real value and lasting worth.

I do not for a minute maintain that a thorough knowledge of the laws of chemistry is not important and if we were preparing all, or even the majority of our students for college, they might well become the objects of our primary interest for a thorough understanding of chemical laws is essential to a thorough knowledge of chemistry. For those students classified by their mates under the general heading of "chemistry sharks" and who are likely to go into chemistry seriously we can and must do more than we do for the average student. Conference groups, extra assignments, reference assignments, especially to that invaluable "Handbook of Chemistry and Physics," special work on solubility and solution, opportunity to do work as laboratory assistants; these things and many more will help our outstanding students to lay a broad foundation upon which the college instructor may build.

Reference work for chemistry pupils has always seemed to me to be especially worthwhile. The amount of chemistry that we can teach any pupil is very small, even in a four-year college course, but by a liberal use of reference works we can place at our students' disposal the great mass of materials collected and compiled by the greatest chemists of all ages. In this connection I have always been guided by a remark of the best and most loved teacher of my own school days when he said, "Physics is so big a subject that I can't teach you people much but I can show you where to find the facts when you need them and that, in some respects, is better than knowing them yourself"—a remark which applies with equal force to chemistry.

Many teachers seem to hesitate about sending pupils to reference works, apparently under the impression that it implies a lack of knowledge on the part of the teacher. This should not be the case. The best commercial and plant laboratories have the best-equipped libraries which are constantly referred to by the technical staff from the chief chemist down. Why, then, should we deny, or at least say nothing about, the use of reference works to our pupils?

Possibly the ideal arrangement for high schools would be to separate our students into two groups of classes. In one group we would put those pupils who have only a very passive interest in chemistry and no

expectation of going to college and in the other we would place those pupils who are actively interested in chemistry or who expect to take more in college. Then we might teach two kinds of chemistry; for one group stressing the laws and theories of the science while for the other we would place special emphasis upon the applications of chemistry to everyday life with only slight attention to laws and theories. In other words we would teach a practical chemistry for those who expect to go no farther in the science and a theoretical chemistry for those who would get their practical applications later. However, such divisions are very difficult to make and might open up even greater difficulties than those which we now face.

In conclusion, Mr. Standard Maker and teacher of college chemistry, pray remember that the high-school teacher is facing facts, not theories. We must meet as best we can the demand for instruction in chemistry from those who are going no farther than high school as well as from those who are going to college. After all our work lies in doing the best we can for the greatest number and if our student enters your college somewhat remiss in those things which you feel essential to one who has completed a year's work in chemistry we beg of you to treat him kindly and forgive us his faults, and our own, if you can. If you cannot, go forth and have a talk with the man who takes your students when you are done with them and gives them their next year of chemistry. Ask him what he thinks about their knowledge of chemistry acquired under your efficient tutelage and then, if he becomes impolite and gives you his honest, unbiased, and truthful opinion, we predict that you will emerge with a chastened spirit and a somewhat more tolerant and kindly feeling toward your fellow-laborer in the lowly vineyard of the high school.

Aluminum Tubing Replaces Gas Pipes in Germany. Light, thin-walled drawn aluminum tubing, which can be bent at right angles instead of having to be cut and screwed into angle fittings, is coming into use in Germany to replace the old-style heavy iron pipes used in houses for carrying cooking and lighting gas.

It is claimed that the new tubing can be used in considerably smaller sizes than iron pipes, not only because of its thinner walls but because it is completely smooth inside and therefore offers less resistance to the flow of the gas. It is also much less unsightly than the old pipes.

Angles are bent in it at any desired point by means of a special hand-operated tool employing a clamp and two channelled rollers. Where joints or T-fittings are necessary self-sealing aluminum castings are used.

The tubing is made in sixty-foot lengths, which can be coiled up and carried over the workman's shoulder if necessary, thus reducing the expense of cartage and eliminating the traffic dangers attendant to having long lengths of stiff piping sticking backward out of a truck.—*Science Service*

CHEMISTRY EXHIBITS IN THE SMALL LABORATORY

JOHN J. CONDON, NOTTINGHAM HIGH SCHOOL, SYRACUSE, NEW YORK

In the small laboratory, especially where the instruction in two or more sciences must be given by the same instructor, and perhaps in the same laboratory, the problem of finding good specimen materials and storing them from year to year for other classes involves very careful planning. Much more important is the source of the materials, with economy of space.

Jensen and Glenn,[1] have shown that in South Dakota in 1926 "a typical four-year high school offered two sciences with an enrolment of from ten

FIGURE 1.—"ONONDAGA POTTERY" DISPLAY IN FOREGROUND, WITH THREE METHODS OF MAKING BAKING POWDER TO THE RIGHT

Some of the posters, reading from left to right, are New Types of Planes, above it, Physics in the Kitchen, to the right, Automatic Fire Extinguisher, Rayon and Silk, Dry Cell, Asbestos, and Radio Tubes.

to twenty pupils . . . . . that the value of the equipment was greatest in chemistry and physics . . . . Combined with their teaching 60% had extra curricula duties." Phelan[2] found a like condition in Ohio and Worstell[3] finds the smaller schools in Iowa introducing chemistry in addition to other sciences. "Getting more students interested in the course is our biggest task," is the teachers' opinion in that section, also. Such conditions are found, in a similar degree, with each state survey. With the seemingly

[1] THIS JOURNAL, **6**, 634–64 (Apr., 1929).
[2] *Ibid.*, **6**, 2196–202 (Dec., 1929).
[3] *Ibid.*, **6**, 1503–11 (Sept., 1929).

large number involved it is hoped that this suggestion may be of assistance to many.

The idea of the "Exhibit" is not new. Many colleges as at Rhode Island, Syracuse, and Iowa use extensive exhibits, and some high schools have used the idea with success. Reports of some[4] have appeared frequently. The methods we have used and the scope of the undertaking is somewhat different than in the previous articles, which were very helpful in our problem. The desire was to teach the applications of chemistry, creating enthusiasm and interest in chemistry, while collecting materials for future use.

After consulting the syllabus and texts used, several items were decided to be of such importance and degree of difficulty asto (1) lend themselves more easily to forms of illustrative matter. (2) Another list was made of the subjects where definite forms of specimen materials would aid in explanation. (3) Then those items which would enrich the course were listed. Representative concerns were enumerated for each group, and two or three were placed opposite each item.

FIGURE 2.—TEXAS SULFUR, RUBBER PRODUCTS AND SOAP IN FOREGROUND

The posters include Vitreosil Ware, Rayon and Silk and Asbestos. Part of the pottery display and the Methods of Making Baking Powders, shown in Figure 1, are on the desk below these posters.

As an example, from the first group, the extraction of sulfur by the Frasch method has been difficult for many. How does one pipe fit into the other? Why can sulfur rise in but one? How can it come out of that pipe? . . . are but some of the questions. Since our exhibit this has been presented in THIS JOURNAL,[5] *Popular Science*,[6] and more recently in the *Chemistry Leaflet*.[7]

The idea of the Exhibit was given to our students in these statements.

[4] A. H. Jacobs, THIS JOURNAL, **2**, 792–4 (Sept., 1925). F. L. Bell, *Ibid.*, **5**, 157–67 (Feb., 1928). J. E. Mahannah, *Ibid.*, **5**, 1112–26 (Sept., 1928). S. D. Law, *Ibid.*, **6**, 1139–42 (June, 1929). C. H. Stone, *Ibid.*, **6**, 1535–41 (Sept., 1929).

[5] *Ibid.*, **6**, 129–38 (Jan., 1929).

[6] *Pop. Sci.*, **113**, 26, 151 (Dec., 1928).

[7] "The Sulfur Family," *Chem. Leaflet*, **3** (Oct. 31, 1929).

FIGURE 3.—STANDARD OHM, CELL (B. OF S. 1885), AND GALVANOMETER IN FOREGROUND

Posters include Food Products, Laminated Resinoids, Graphs, Dyes, Making of Shingles, and Making of Paints.

An Exhibit will be held in this room in about six weeks. You are asked to help in assembling material which will be solicited. The names of the concerns will be furnished to you as will be the paper for the letters you will write. You will be advised of the materials desired should you not be entirely familiar with the products. Yes, we are going to ask you to supply the stamps. Each will write about three letters, though some will write more than that number. The form of the letter will be suggested, and your writing materials are all that will be necessary in class tomorrow.

From the prepared lists suggestive of different possibilities each student was asked to select a commodity for which he thought he might be able to get an exhibit showing its sources, steps in manufacture, and uses. Form letters were put on the board and three to five names of concerns known to manufacture the item were given the student. Each of the members of the chemistry class was given information concerning the selected materials

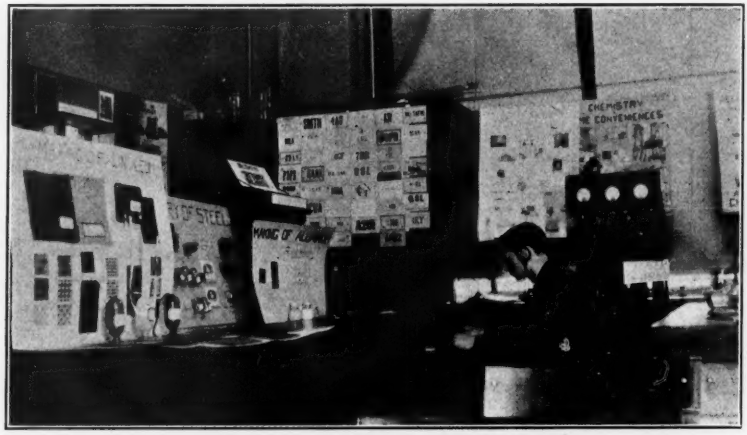


FIGURE 4.—MR. WOOD AT THE RADIO SENDING APPARATUS
Posters include the Making of Linoleum, Chemistry of Steel, and Making of Aluminum. The Pyrex display is on the right.

or illustrative matter desired from that organization. The same procedure was carried out with the students in physics, although they did not write as many letters. Where possible, one letter was directed to a New York state concern having the desired information, and others were directed to divers sections of the country. The entire period was used in preparing the letters. It was requested that the replies be sent to the individual student in care of the chemistry department, and, to add prestige, the request was written on department stationery.

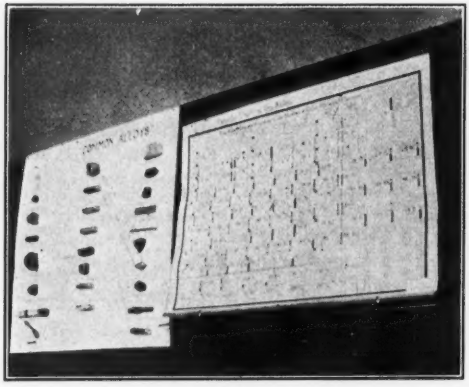


FIGURE 5.—TYPICAL CHARTS
In the chart on Common Alloys, the metals are in the center and the common alloys are on either side. A better reproduction of the Periodic Chart of the Atoms on the right will be found in THIS JOURNAL, 6, 553 (Mar., 1929).

Every student was urged to secure from every available source all the information possible regarding his product, so that he could best explain its manufacture, properties, and uses to the class when it arrived.

Prizes were offered for the exhibit or poster showing the most thought on the part of the student arranging it so that it would tell its story most clearly to the visitor.

Interest was indeed keen when the replies began to come in. We found a very marked spirit of courtesy and real interest in almost every reply, even though we did not receive material from every one. The first part of the period for three days in the two weeks during which the material arrived was used to unpack, examine, and label until the time for the final assembling.

Posters were made by both groups and in some cases titles were suggested to the students but the enthusiasm brought many new titles and ideas, most of which were used.

As an example of the posters presented, the one by Harold Lawton (Figure 5) on the various combinations of nine of the elements to form many alloys was condensed very neatly. Another by William Woodcock, on the chemicals used in the manufacture of the airplane which gave formulas and sources of materials, was timely and elaborate.

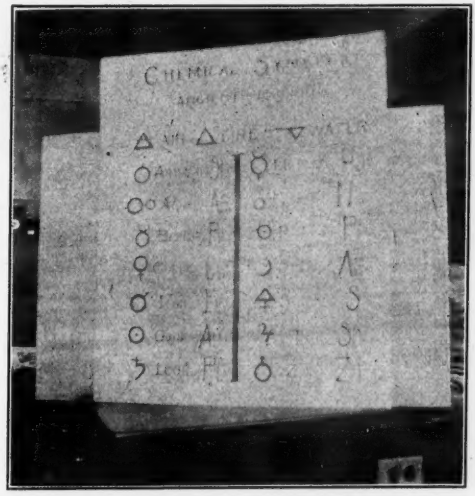


FIGURE 6.—CHEMICAL SYMBOLS COMPARED

Original posters deserving comment were those by Stuart Graves of a "New Periodic Chart"[8] and a set of eight "Cooling Curves."[9] Miss Elizabeth Hopkins compared the present and past symbols used in chemistry (Figure 6).

A list of some of the better posters, 59 of which were made by the two groups, are:

Chemistry in the Automobile-Metal Parts; Other Parts.
Physics with the Automobile Engine; Electrical System; Other Parts.
Chemistry in the Kitchen.
Physics in the Kitchen.
Chemistry in Our Outside Pleasures.
Physics Helps Us to Enjoy Ourselves.
Physics and the Christmas Toys.
Evolution of Chemistry.

[8] THIS JOURNAL, **6**, 553–6 (Mar., 1929).
[9] *Ibid.*, **6**, 776–7 (Apr., 1929).

FIGURE 7.—DISPLAYS INCLUDING PETROLEUM PRODUCTS, MAKING OF LINOLEUM, COTTONSEED OIL, AND KLEENEX

Preserving Foods by Chemistry.
Fire Prevention through Chemistry.
Chemistry in Health.
Chemistry in Our Home Conveniences.
Evolution of Heating Devices.
Early Airplane Models.
Types of Radio Tubes.
General Types of Graphs.
Chemistry Dresses the Man.
Graphs in Heat, Light, and Sound.
Chemistry Helps to Furnish the Home (2).
Kill Pests.
Chemistry Builds the Home.
Chemistry Prepares Our Foods.
Physics Improves Transportation.
Physics Lightens Our Work.
Chemistry in Milady's Toilet.
Modern Airplane Types.

The best arranged exhibit was that done by Miss Eleanor Frost (Figure 2) with the products of the Vitresol Company. The most complete commercial exhibit (Figure 1) was loaned to us by the Onondaga Pottery Company, a local concern. We were fortunate in being able to have this most instructive and enlightening display which was received from Harvard University the week previous, where it had been on exhibition. It is now a traveling exhibit of that concern to ceramic schools and colleges. The Stackpole Carbon Company sent a very fine set of their products on a display board. The samples from the makers of Pyrex glassware, and the Solvay products were very complete. Obordorfer Metal Company alloys and metals, given to us by this friendly Syracuse maker of non-ferrous metal products, were used in several posters and to supplement many exhibits. From the northern part of the state, which abounds in several kinds of mineral deposits, W. H. Loomis Co. sent a set of samples of talc.

Individual projects using these types of material sent by over one hundred concerns are the following:

Common Alloys.
Comparison of Liquids (densities).
Evolution of Silk.
Making of Bordeaux Mixture.
The Story of Steel.
How Carborundum Is Made.
Making of Aluminum.
Sensitive Flame.
Jumping Helix Coil.
Lead Tree.
Construction of a Dry Cell (two forms).
Construction of the Storage Battery (two forms).
Building an Electric Motor (progressive assembly).

These were supplemented by a collection of minerals from some of the western states loaned by Mr. Scott. Mr. Sundstrom, of the Solvay Co., loaned a cluster of sodium chloride crystals obtained in a crater of a receded lake in Nevada. Some of the crystals measured one and three-fourths inches on a side and were colored due to animal growths. Prof. Kelleter, of the College of Forestry at Syracuse, gave us a copy of the first magazine made from cornstalks. Samples of rayon, imitation horsehair, and equivalent weights of balsa and lignumvitae woods were some of the other materials he was kind enough to loan to us. None created as much interest as the crystals of cellobiose, and the samples showing the stages in preparation of the compound, which is part of our permanent display.

We have been able to include but a few of our many kind contributions, but would send additional information to any one desiring the same. You may find your community—parents, friends, industrial plants—will be pleased to help you, too. Our experience suggests that to be the case. Isn't it worth a trial?

The time set for the Exhibit was the week during which a play was to be presented in the auditorium. Students of the school were asked to come in the afternoon of the first day. Members of the class acted as ushers and guides. The room was opened before and after the entertainment. As an added attraction Robert Wood, a member of the physics class, and first-class commercial radio operator, sent radiograms to all parts of the United States (Figure 4). This was the initiation of 8 WCJO, the Nottingham High School transmitting station. Mr. Wood, on advice of the writer, had obtained our operating license three weeks previous.

It was my impression, as I watched the people pass through and heard their remarks, that the majority of people whom we consider the intelligent class of a community were very much impressed and surprised at the important part chemistry is playing in our everyday lives and many were amazed at some of the facts brought out by these exhibits, which we as chemistry teachers consider as very matter-of-fact information. Yet the general public does not realize the tremendous importance of chemistry, and here, I believe, is a wonderful means of "selling" it to them.

SOME PROJECTS IN CHEMISTRY

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

Chemistry, like physics, is essentially a laboratory science. Most of what we know about either subject has been learned by careful experimentation, close observation, and thoughtful reasoning about the observed results. It would appear that a similar procedure should be an acceptable method for the beginner. Nobody, of course, expects the neophyte to rediscover Avogadro's Principle, the Law of Gay-Lussac, or the rate of diffusion of gases, but there is much knowledge which he might uncover for himself under suitable conditions.

Our textbooks in chemistry give in considerable detail the properties of the common elements and their chief compounds. The student who goes to the laboratory to prepare one of these substances knows in advance what results he should obtain. He knows that the carbon dioxide he is presently to prepare will be colorless, odorless, will not burn, and will turn lime water milky. He knows that the ammonia gas about to be made will be colorless, extremely soluble in water, and will not support combustion. It seems a pity that our textbook writers should thus, by telling the student everything which he might find out for himself, destroy that joy of discovery which otherwise might be his. Knowing, as he does, what results are to be obtained in almost any of the ordinary experiments, the student sinks from the rôle of a discoverer into that of a verifier and under such conditions laboratory work may become more or less a perfunctory performance deriving much of its value from the acquisition of certain manipulative skills.

With the thought of providing some experimental work in which the results of experiment would not be known in advance, certain projects were devised for use in our chemistry classes. In casting about for material, several propositions were considered. At last we decided upon the projects involving the conversion of crude materials into finished products.

What can be more interesting for the student of chemistry than to start with a sample of some ore, say witherite, and proceeding under direction finally produce the beautifully white crystalline product, barium chloride? There are many such projects which are within the ability of the student and which provide an avenue of escape from the usual procedure of the laboratory. There is also the added incentive of preserving samples of the original and the finished product; these samples are tangible substances of distinct color or crystalline form quite different from the monotonous similarity which a series of samples of the ordinary gases would have.

Recently we gave one of our students some magnesite to be worked up into Epsom salt. The ore was crushed in an iron mortar and the

powder was slowly added to fifty cubic centimeters of dilute sulfuric acid with constant stirring until effervescence ceased. The sirupy product was heated with addition of a little more of the powdered ore until it was evident that the acid had been completely converted into the salt. Water was then added, the liquid was well stirred and filtered into a clean crystallizing dish. The dish was set aside and after some days when most of the liquid had evaporated, crystals of the salt were seen in abundance. The mother liquor was drained off, the crystals were dissolved again in as little hot water as possible, the liquid filtered and recrystallized. Glassy crystals of the salt were produced. These were filtered off, dried on blotting paper, and a sample put up. A specimen of the anhydrous salt was obtained by gently heating the crystals. The student may now write a little book telling the story of how his product was obtained and this, with his various samples, can be made into an attractive poster. Such work as this enlists at once the interest and effort of the student.

Another student, starting with malachite ore, produced specimens of copper and the chief copper salts. Another one produced antimony chloride solution from stibnite. The ore was powdered and treated under the hood with concentrated hydrochloric acid until no further evidence of hydrogen sulfide was noted. Too large an excess of the acid was avoided. The product was then filtered and you should have seen the student's eyes open when he let a drop of the liquid fall into a graduate full of cold water. If interest is a thing to be desired certainly nothing we have ever tried has given us more satisfaction in the interest evoked and the effort put forth in this kind of work.

Another project was: What shall we do with the marble dust that we find in considerable quantity in the calcium carbonate we buy? The dust was sifted out, treated with dilute hydrochloric acid till nearly dissolved, the liquid heated to expel carbon dioxide, and then evaporated to dryness to expel any excess of acid. The residue was taken up with water and any iron present precipitated by cautious addition of ammonium hydroxide. The iron hydroxide was filtered off, and the filtrate evaporated to dryness, using a small flame along toward the end and keeping the material well stirred. A lumpy white product was thus obtained which answers well enough for our use as calcium chloride. We use specimens of this preparation to show the rapid absorption of ammonia gas over mercury and always state that the material used was prepared by student So-and-so.

Teachers who may desire occasional experimental material somewhat different from that of the usual laboratory manual may do well to undertake some work of the kind outlined above. Our experience has been that students will respond eagerly to an occasional proposition like this: "We are running low on barium chloride, Jack. Would you like to make

one hundred grams of it for us?" There are few students, I think, who would not jump at such a chance.

When a student has completed a project of this kind, say the preparation of one hundred grams of lead nitrate from litharge or cerussite, he finds much satisfaction in seeing his product put into a bottle on a shelf in the laboratory for general use and labeled "Made by ....." That his product is not chemically pure is true but it is good enough for general use.

It may be argued that this is advanced work which ought not to be taken up until the pupil has finished the usual course in general chemistry. In reply, we may ask: "In what way is this advanced work? Are the processes of solution, filtration, evaporation, and crystallization any different than they are in the preparation of the usual substances? Are the chemical equations for the reactions involved any more complicated than are those of our customary experiments? Is the reaction between lead oxide and nitric acid as difficult to understand as is that between copper and nitric acid? Is the decomposition of copper carbonate in the preparation of copper oxide any more difficult to comprehend than is that for the decomposition of potassium chlorate? Should you think that the pupil who understands the reaction between calcium carbonate and hydrochloric acid ought to have any difficulty in understanding the reaction between cerussite and nitric acid?" It does not seem so.

Obviously experiments of the type described above ought not to displace those which are required in the usual course. But wherever opportunity of time and ability on the part of the individual student seems to warrant, work of this type may be undertaken with the assurance that there will develop a new interest and enthusiasm not equaled by that shown toward the ordinary preparational work.

Electron Bullets Kill Germs. Electron bullets, fired with electricity as low as thirty volts, which can be obtained from a battery of twenty dry cells, are capable of killing at least one common form of germ. In a study made at the University of Cincinnati, Dr. D. A. Wells has found that *Staphylococcus albus*, the mildest of several germs that produce boils, are destroyed by these relatively low-speed electrons, moving at speeds of a few miles a second. High-speed electrons, driven by voltages of several thousand, have already been observed to have a germ-killing effect.

Modern theories suggest that electrons are similar to forms of radiation like the ultra-violet rays, which also kill germs. To help find how this happens, Dr. Wells began the work on the electrons.

The germs must be rayed in a vacuum tube, but those used in the experiment could be kept for eight hours in a vacuum one-fifteen millionth the density of ordinary air without killing them. When bombarded with electrons of 30 volts' energy they were quickly killed, but with lower voltages they survived. The more energy in the electrons, the more germs were killed.—*Science Service*

THE CONCEPT OF THE POUND-MOLECULAR-VOLUME

C. E. RONNEBERG, CRANE COLLEGE, CHICAGO, ILLINOIS

Teachers of the exact sciences are so used to thinking in terms of the c. g. s. system of units that often we little appreciate the fact that there are many situations in which it is better or even necessary to work with other units, as the f. p. s. system of units practically universally used in the industries of this country, Canada, and Great Britain. A problem from the field of chemical industry illustrates this point. *A certain chamber acid plant utilizes 525,000 cubic feet of by-product sulfur dioxide daily, expressed as pure sulfur dioxide at S. T. P. How many pounds of 96% sulfuric acid of density 1.84 does this volume of gas correspond to?* Many teachers in order to solve this problem would first convert the volume of gas in cubic feet to liters and then solve the problem in the usual way as a problem of the weight-volume type based on an equation. The weight of acid obtained, of course, would be in grams, and this answer would then have to be recalculated to the answer in pounds. It is worthwhile emphasizing that the above method of solving the problem is unnecessarily long and involves a reliance upon the c. g. s. system of units that to the writer seems unwarranted. From the standpoint of practical mathematics we should always remember that the shorter we can make a given solution for a problem, the less is the possibility of making arithmetical errors.

The above type of problem may be solved in a simpler manner by the use of either the concepts of the "ounce-molecular-weight" and "ounce-molecular-volume," or the concepts of the "pound-molecular-weight" and "pound-molecular-volume," all of which correspond to the familiar ideas of the "gram-molecular-weight" and "gram-molecular-volume." One ounce-molecular-weight of oxygen, for example, is thirty-two ounces. The volume occupied by this weight of oxygen (S. T. P.) can be referred to as the ounce-molecular-volume and should be expressed in cubic feet. Dr. T. W. Richards, I believe, was the first to point out the very singular coincidence that the ounce-molecular-volume of a gas happens to be *22.4 cubic feet.* This should be apparent from the following calculations:

$$
\begin{aligned}
\text{32.00 oz. oxygen} &= 32.00 \times 28.35 \text{ g. (1 oz. = 28.35 g.)} \\
&= 907.0 \text{ g.} \\
\text{Volume of 32 oz. oxygen} &= \frac{907.0}{1.429} \times 1 \text{ (1 l. oxygen S. T. P. weighs 1.429 g.)} \\
&= 634.7 \text{ liters} \\
&= \sout{634.7 \text{ cm.}^3} \qquad 1\ m^3 = 1000\ l = 1{,}000{,}000\ cm^3 \\
&= \frac{634.7}{1000} \times 35.31 \text{ (1 cubic meter = 35.31 cu. ft.)} \\
&= 22.4 \text{ cubic feet.}
\end{aligned}
$$

Hence as an application of Avogadro's theory we have the very unusual relationship that *one ounce-molecular-weight of any gas (S. T. P.) occupies 22.4 cubic feet.* The use of this concept is entirely analogous to the use of the concept of the gram-molecular-volume.

Perhaps even more useful in solving problems based upon equations when the common English units are involved, is to make use of the ideas of the pound-molecular-weight and pound-molecular volume, the volume in cubic feet occupied by one pound-molecular-weight of a gas at S. T. P. This volume is numerically 359 cubic feet as shown below. Consider, for example, 2.016 pounds of hydrogen, which is one pound-molecular-weight.

$$\begin{aligned}
\text{Weight in grams} &= 2.016 \times 453.6 \text{ (1 lb. = 453.6 g.)} \\
&= 914.5 \text{ g.} \\
\text{Volume of hydrogen} &= \frac{914.5}{0.0900} \times 1 \text{ (1 l. hydrogen S. T. P. weighs 0.0900 g.)} \\
&= 10{,}160 \text{ liters} \\
&= 10{,}160 \text{ cm.}^3 \\
&= \frac{10{,}160}{1000} \times 35.31 \\
&= 358.8 \text{ cubic feet.}
\end{aligned}$$

This volume, of course, is also *the volume of one-molecular-weight of any gas under standard conditions*. Because of the known variations in the gas laws, the above volume should be expressed as accurate to only three significant figures or 359 cubic feet.

The use of the above derived concepts is similar to the use of the concepts of the gram-molecular-weight and the gram-molecular-volume. The following solutions of typical problems should make this clear.

Problem 1. What volume of sulfur dioxide (S. T. P.) could be obtained by burning two thousand pounds of pure sulfur?

$$\underset{1 \text{ mole}}{S} + O_2 \longrightarrow \underset{1 \text{ mole}}{SO_2}$$

First solution:

$$\text{Number oz.-moles sulfur used} = \frac{2000 \times 16}{32} = 1000$$

Number oz.-moles SO_2 possible = the same = 1000

Hence volume $SO_2 = 1000 \times 22.4 = 22{,}400$ cubic feet

Second solution:

$$\text{Number lb.-moles sulfur taken} = \frac{2000}{32}$$

Number lb.-moles SO_2 possible = the same

$$\text{Hence volume } SO_2 = \frac{2000}{32} \times 359 = 22{,}400 \text{ cubic feet}$$

Problem 2. In a fermentation vat carbon dioxide was being formed at a rate of twenty-five cubic feet per hour. What weight of sugar as dextrose is being converted to alcohol per hour?

$$\underset{1 \text{ mole}}{C_6H_{12}O_6} \longrightarrow 2C_2H_5OH + \underset{2 \text{ moles}}{2CO_2}$$

First solution:

$$\text{Oz.-moles } CO_2 \text{ formed per hour} = \frac{25}{22.4}$$

$$\text{Oz.-moles dextrose fermented} = \frac{1}{2} \times \frac{25}{22.4}$$

$$\begin{aligned}
\text{Hence weight dextrose fermented} &= \frac{1}{2} \times \frac{25}{22.4} \times 180 \\
&= 100.7 \text{ oz.} \\
&= \frac{100.7}{16} \text{ or } 6.28 \text{ lb.}
\end{aligned}$$

Second solution: Lb.-moles CO_2 per hour $= \frac{25}{359}$, since one pound-mole of a gas occupies 359 cubic feet

$$\text{Lb.-moles dextrose fermented} = \frac{1}{2} \times \frac{25}{359}$$

$$\text{Hence weight dextrose fermented} = \frac{1}{2} \times \frac{25}{359} \times 180$$

$$= 6.28 \text{ lb.}$$

An inspection of the above two methods of solution shows that the method making use of the idea of the pound-molecular-weight and pound-molecular-volume is a little simpler mathematically, as the use of the idea of the ounce-molecular-weight requires somewhere in the solution the conversion of pounds to ounces or the reverse operation. However, it is true that the use of the number 359 is a little awkward as it is a number which cannot be factored. Calling the pound-molecular-volume 360 cubic feet means introducing an error of only one part in 359 or less than 0.3%, an error which in most cases is negligible, as the known deviations in Boyle and Charles' laws in many cases are greater than this amount. The number 360, of course, is factorable in many ways, and for this reason it might be advantageously substituted for the quantity 359.

The sample solutions given above have been solved by the so-called mole method. It should be apparent that the equally correct proportion method of solving problems based upon equations could be used. For example, consider the problem given in the introductory paragraph. The equations for the series of reactions involved in the conversion of sulfur dioxide to sulfuric acid can be summed up as follows:

$$2H_2O + 2SO_2 + O_2 \longrightarrow 2H_2SO_4$$
$$2(360) \text{ cu. ft.} \longrightarrow 2(98) \text{ lb.}$$
$$720 \text{ cu. ft.} \longrightarrow 196 \text{ lb.}$$
$$525{,}000 \text{ cu. ft.} \longrightarrow x \text{ lb.}$$

The proportion becomes: $\frac{720}{525{,}000} = \frac{196}{x}$

Hence $x = \frac{(196)(525{,}000)}{720} = 142{,}900$ lb.

This represents 100% acid; the weight of 96% acid would be $142{,}900 \times \frac{100}{96} = 148{,}900$ lb.

As far as the writer knows, there are very few chemistry texts that make any reference whatever to the ideas of the ounce-molecular-volume and the pound-molecular-volume. In view of the simplicity of these ideas and their usefulness, should this condition prevail? As long as the English units of measure are still so common, problems will continually arise involving these units. To solve these problems using c. g. s. units involves the use of conversion factors, which are easily forgotten. Solutions using the English units will be more direct and simpler. For instance, compare the following two solutions to the same problem.

Problem: A steel tank of 8 cu. ft. capacity is filled with oxygen under a pressure of 100 lb. per sq. in. and a temperature of 68° F. What is the weight of the oxygen in the tank neglecting deviations from the gas laws?

First solution: 68°F. = 20°C.

$$\text{Pressure in atmospheres} = \frac{100}{14.7} = 6.80$$

$$\text{Volume gas S. T. P. in cubic feet} = 8 \times \frac{273}{293} \times \frac{6.8}{1} = 50.6$$

$$\text{Volume gas in liters} = 50.6 \times 28.32 \text{ (1 cu. ft. = 28.32 l.)} = 1435$$

$$\text{Weight } O_2 \text{ in grams} = \frac{1435}{22.4} \times 32 \text{ (22.4 l. } O_2 = 32 \text{ g.)} = 2050$$

$$\text{Weight } O_2 \text{ in pounds} = \frac{2050}{1000} \times 2.20 = 4.51 \text{ lb.} \quad \text{Answer}$$

Second solution:

$$\text{Volume gas S.T.P.} = 8 \times \frac{273}{293} \times \frac{6.8}{1} = 50.6 \text{ cu. ft.}$$

$$\text{Weight oxygen} = \frac{50.6}{359} \times 32 \text{ (1 P.M.W. } O_2\text{, 359 cu. ft. = 32 lb.)} = 4.51 \text{ lb.} \quad \text{Answer}$$

A comparison of the two solutions shows that the second solution making use of the idea of the pound-molecular-volume is superior from the standpoint of simplicity, freedom from the use of awkward conversion factors, and because it involves fewer arithmetical operations.

In concluding, may I emphasize that the writer is not putting forth a brief for the retention of the f. p. s. system of units? He merely wishes to call attention to the fact that it is unscientific to slavishly rely on the use of the metric system of units in situations where the English units are in common use. In such cases, as a matter of fact, the use of the metric units is often a distinct handicap. This is especially true when working with problems which involve volumes of gases expressed in cubic feet. In such cases, the concept of the ounce-molecular-weight or of the pound-molecular-weight might advantageously be used.

Claude's Attempt to Utilize Energy of Gulf Stream. The French scientist, M. Georges Claude, developer of neon gas lights and important synthetic processes, is proceeding with an extensive investigation at Matanga, Cuba, to utilize the potential heat energy of the Gulf Stream. The surface water there is said to be 40 degrees warmer than the water 2000 ft. below. Claude expects to develop a practical means of transferring this heat energy difference-potential and utilizing it. The preliminary plans involve dropping a pipe line to the bottom to bring up the cold water, taking off the power through use of the turbine engine which takes advantage of the flow of vapor set free by the proximity of water at two different temperatures. Local engineers believe that his project probably includes search for gases present in the water at the ocean bottom.—U. S. A. COMMERCIAL ATTACHÉ TODD, HABANA, via *Chem. Age*

PREPARATION OF A SYNTHETIC RESIN

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

It has long been known that phenols and aldehydes will react with each other to produce insoluble resinous products. It remained for Baekeland to perfect the process and, using suitable controls of temperature and pressure, to produce materials of such beauty and such manifold uses that the trade-mark "Bakelite" has become a household word.[1]

It is improbable that an amateur can obtain results at all comparable to the product of the industrial expert but it is easily possible for any one to produce a solid, hard as horn, of varied colors, and insoluble in water and other solvents. After numerous trials, many of which were failures, the following procedure has been found to produce a satisfactory result. The experiment should be performed under the hood or in a good draft by an open window, since the materials used are poisonous.

Put 10 grams phenol into a clean dry six-inch test tube and on top of the phenol put 6.4 grams of paraformaldehyde. Heat the tube gently; the phenol will melt and the paraform gradually dissolve in it. Avoid too high a temperature as the escaping vapors are intensely irritating as well as dangerous. When the paraform has completely dissolved and a clear liquid has been obtained, add a small speck of any solid dyestuff and warm and shake gently till the color is uniformly distributed.

Now fill a tumbler two-thirds full of cold water and set it within easy reach. To the hot melt in the tube, add a bit of solid sodium hydroxide the size of a pin head. If the liquid in the tube is sufficiently warm, action will begin and increase in vigor. If the action does not begin, warm the tube slightly. If the action becomes rather violent, thrust the tube for a moment into the cold water in the tumbler. With too violent action, a froth is formed which will solidify in the tube to a brittle substance. When the action has abated considerably, another small bit of sodium hydroxide may be added with cautious heating. Finally, the thick pasty material may be poured into any mold desired and set aside on the top of a steam radiator or other pretty warm place for several days for the completion of the reaction. The final product will be hard and give forth a sharp sound when tapped with a pencil point. If left a sufficient length of time, the product will readily come out of the mold and show a perfect reproduction of the shape and lines of the mold.

The covers of small tin cans make good molds, particularly those having stamped letters or designs; small test tubes may be used, or little jelly molds obtainable at the ten cent store. A pleasing variation may be made by preparing two liquids of different colors and pouring one of these on top of the other into the mold, thus producing a two-color effect. If the mixture is stirred just a little a curious mottled effect will be obtained.

The final product is rather brittle but with careful handling may be drilled, filed, and otherwise worked as desired. Teachers who are looking for something new for personal work will find the preparation of this material interesting, but one must be prepared to make several attempts before complete success can be obtained.

[1] See "Nature Was Notably Aided," A. V. H. Mory, THIS JOURNAL, 6, 607–21 (Apr., 1929).

THE MULTIPLE PREPARATION OF HYDROGEN ELECTRODES

V. Richard Damerell, Western Reserve University, Cleveland, Ohio

During some recent research work,[1] dealing with colloidal aluminum hydroxide, it was found that the hydrogen electrodes employed to measure the pH values of the sols began to give low voltage readings after a certain amount of use. This necessitated the frequent preparation of new electrodes, and in an attempt to save time at this task the technic outlined below was later developed. Since many other types of chemical work require the preparation of a great number of electrodes, it was thought that the publication of these notes might be of aid to other investigators.

The method was worked out using platinum foil for the electrodes, and while it is undoubtedly applicable to other types, some changes would have to be made before it would apply to these.

Experimental

Building the Electrodes.—The electrodes had to be put together individually, and the general method employed was that given by Clark.[2] The pieces of foil were cut square, and approximately 0.75 cm. on a side. The wires were cut about 2 cm. in length. Unless the surface of the foil was bright, it was usually rubbed with the rounded end of a glass rod. This operation, by causing the platinum to become quite bright, later made it easier to tell, during the electrolysis in $PtCl_4$ solution, when the coating of platinum black was of sufficient thickness, and also improved the appearance of the coating. For welding the wire to the foil, a Meker burner was clamped to a ring stand in such a position that the flame played directly on the two, which had been carefully set in position on a smooth iron surface of some sort. When the electrode and wire came to a red heat, the flat end of a small iron bar was tapped forcibly down on the junction of the two. A good weld usually resulted. The end of this bar away from the flame had been thrust through a cork stopper which in turn was gripped by a buret clamp on a stand. The bar was thus able to be accurately set in place. At the proper time, the upper end was rapped smartly with a wooden block, completing the weld.

The foil and wires were placed in the drawn out ends of short pieces of soft glass tubing (5–7 cm.), and the glass was then fused around them, leaving the end of the wire inside of the tube to make contact with the mercury that was added later. This was done entirely in accordance with the method given by Clark.[2]

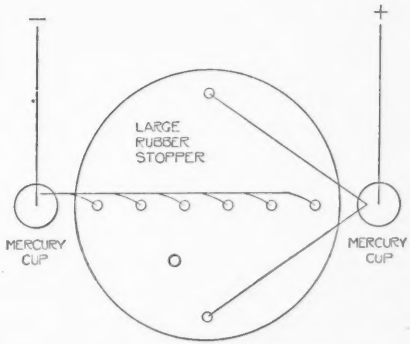
Construction of the Apparatus Used in Preparation of the Electrodes.—After making the electrodes, all subsequent operations, including saturation of the electrodes with hydrogen preparatory to use and removal

[1] In the course of publication.

[2] Clark, "The Determination of Hydrogen Ions," 2nd edition, The Williams & Wilkins Co., Baltimore, Md., 1925, p. 173.

of deposits from old electrodes, were performed in the same apparatus, and in multiple. Six electrodes were treated at once, and this number could be increased further if desired.

Nine holes were bored in a large rubber stopper, as shown in the figure. The six in a row were for the electrodes being treated. The two symmetrically opposite were for the reference electrodes; old, discarded hydrogen electrodes being generally used for this purpose. A tube, drawn to a tip, went through the ninth hole, to be used in the last operation of saturating the electrodes with hydrogen. The holes for the electrodes were bored such a size that the electrode tubes would fit tightly after being inserted about a centimeter. This saved much time in insertion and removal, and took away much of the danger of sticking. A notch was cut along the side of the stopper to allow the escape of any gas formed. The container was a 400-cc. lipless beaker, although any bottle of sufficient width of mouth and depth could be used. The hydrogen inlet tube was adjusted so that it just missed the bottom of the container, and the foils of the electrodes came a little above this.



PLAN VIEW OF APPARATUS
Hooked up for platinizing.

To carry current to the electrodes, eight 30-cm. pieces of No. 24 double-cotton wound copper wire were cut, and the ends scraped free of insulation. The ends of six of these were wound together, and put into one of the two mercury cups shown in the figure. The ends of the other two were wound together and put into the other. All eight electrode tubes were partially filled with mercury, and into each was put the free end of one of the wires, in such a manner that the six electrodes being treated were connected to one mercury cup and the two reference electrodes to the other. Three Edison storage batteries (six cells) were used in series or parallel as the source of current for the various operations, and wires from these were dipped in the mercury cups. To reverse the current, the wires leading to the cups were reversed.

Cleaning the Electrodes.—This operation was applied to new electrodes preparatory to platinizing and to old electrodes that needed a previous deposit taken off before replatinizing. The treatment was the same for each. After all eight electrodes had been inserted into the stopper, concentrated hydrochloric acid was poured into the container, and the

stopper, together with the electrodes and wires, was put in. Enough acid had been added to completely cover the electrodes. With the three batteries in series, the current was allowed to run for four or five minutes, the six electrodes being treated as the anodes. When the foils became bright, the stopper (still containing the electrodes and wires) was removed, and the electrodes and stopper were thoroughly washed with distilled water. The hydrochloric acid in the container was saved for future use and recovery of platinum.

Electrolysis in Sulfuric Acid before Platinizing.—Enough sulfuric acid, made by pouring one part of concentrated acid of commerce into five parts of water, was put in the container so that the platinum end of the electrodes would be covered completely. The stopper, still containing all of the electrodes and wires, was put into place, and connection made so that the electrodes being treated became the cathodes. With the three batteries in series, the current was allowed to run for several minutes, washing the electrodes thoroughly with hydrogen.

Platinizing the Electrodes.—The stopper, with the electrodes and wires still in place, was removed from the container, the sulfuric acid poured out, and all parts washed well with distilled water. To the container was added a platinum chloride solution containing 5 grams of platinum per liter. The stopper with the electrodes and wires was again put into place. The circuit was completed so that the electrodes being platinized became the cathodes. The three Edison storage batteries were hooked up in parallel, and a dial resistance was put in the circuit. Starting with 50 ohms, the resistance was decreased until deposition at the proper rate took place. A minute or two was considered enough time for the deposit to form, and this rate was usually obtained with a dial resistance of 10 to 20 ohms. Gently agitating the container by hand during this operation seemed to give better deposits. Deposition took place at about 2.5 volts.

Treatment with Dilute Sulfuric Acid after Platinizing.—After platinizing, and thorough washing, the same strength sulfuric acid as was used before platinizing was put in the containers and the stopper, containing the electrodes and wires, was put into place. With the three Edison batteries in series, the platinized electrodes were made the cathodes, anodes, and cathodes in succession, the current being allowed to run for several minutes each time.

Saturating the Electrodes with Hydrogen.—Without removing the electrodes from the sulfuric acid solution employed in the last operation, hydrogen gas, from a tank, washed successively with alkaline pyrogallol and water, was passed in by means of a hydrogen inlet tube. A very slow stream of the gas was bubbled through for several hours. This operation seemed to shorten the time required for equilibrium to

be established when the electrodes were later saturated with hydrogen in the first pH measurement.

After this the electrodes were ready for use, and were transferred to the electrode vessel. Using 0.05 *M* potassium acid phthalate solution, the following voltages were obtained with 12 electrodes, at 25°C., prepared in two successive amounts of six each, and using a normal potassium chloride-calomel-mercury half cell as the reference electrode.

(1) 0.51965 volt	(5) 0.51955 volt	(9) 0.5198 volt
(2) 0.5197 volt	(6) 0.5197 volt	(10) 0.5196 volt
(3) 0.5197 volt	(7) 0.5196 volt	(11) 0.5196 volt
(4) 0.51975 volt	(8) 0.5185 volt	(12) 0.51985 volt

The voltage interpolated from the data of Clark[3] for this combination at 25°C. is 0.5198 volt.

Discussion

The method of treatment outlined above has another advantage besides that of saving time. After insertion of the electrodes into the stopper they are not touched by the hands at any time until ready for use. This eliminates much of the danger of soiling the electrodes, rubbing the foil, or bending it out of shape.

If the voltage drop across the electrodes went very much over 2.5 volts, the platinum black deposited in a spongy form that did not adhere at all readily to the electrodes, and for this reason the parallel hook-up was used for platinizing.

In saturating the electrodes with hydrogen, it was not found necessary to bubble the gas directly on the foil, but anywhere in the solution. Evidently the platinum black adsorbs the gas in solution readily.

[3] Clark, "The Determination of Hydrogen Ions," 2nd edition, The Williams & Wilkins Co., Baltimore, Md., 1923, p. 275.

Find Motor Fuels with Least Knock. Just how much knock automobile fuels used in the manufacture of high-test gasolines do away with has been found.

Three engineers of the General Motors Research Laboratories, John M. Campbell, Wheeler G. Lovell, and T. A. Boyd, who reported their findings before the Society of Automotive Engineers recently, said they tried the different fuels on a standard engine and in each case noted the highest compression at which the engine would run smoothly.

Normal heptane, which knocks more readily than ordinary gasoline, was used as the basis of comparison and varying mixtures of heptane with the more volatile fuels were tested.

Heptane, it was found, first caused knocking when a compression ratio of 2.75 had been reached. Benzene proved to be the most efficient anti-knock fuel as a compression ratio greater than 15 was reached before it began to cause noise. The corresponding compression ratio for toluene is 13.60; for absolute ethyl alcohol, 11.60; iso-octane, 6.90; cyclohexane, 4.50; and normal pentane, 3.80.—*Science Service*

A CHAMBER SULFURIC ACID PLANT FOR LECTURE DEMONSTRATION

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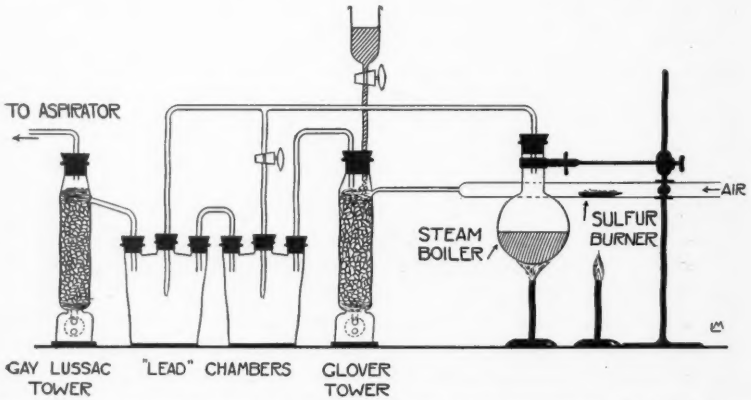
The field of lecture demonstration apparatus is by no means a new one. Many different types of apparatus have been developed to aid the student in grasping the chemical principles involved in certain processes. This is especially true, no doubt, in connection with the teaching of commercial methods for the synthesis of sulfuric acid.

The usual apparatus for demonstrating the chamber process, however well it illustrates the chemical side of the method, shows little if any resemblance either in form or arrangement to the actual sulfuric acid plant of commerce. It was on the hope of obviating this difficulty that the model plant herein described was built. In evolving the plant several



Line Drawing Showing Details of Construction of Chamber Sulfuric Acid Plant

points were kept in mind. First, the apparatus must be of glass so that reactions taking place can be readily observed. Second, except for tubing, the parts should be of standard glassware commonly available. Third, the apparatus should be so arranged as to be easily seen by a group of students, and at the same time follow the arrangement of the commercial chamber process as closely as possible.

The material for the model consisted of a base board 75 cm. × 20 cm., two 25-cm. drying towers, two three-neck 500-cc. Woulff bottles, a small dropping funnel, a 250-cc. boiling flask, and a section of Pyrex combustion tube, 2.5 × 30 cm. Sufficient small-bore tubing is also needed to make the necessary connections.

The Pyrex combustion tube serves as a sulfur burner, the sulfur being contained in a small porcelain boat. A piece of 6-mm. Pyrex tube was sealed to one end of the large tube. This serves to carry the SO_2 to the

PHOTOGRAPH OF ASSEMBLED CHAMBER SULFURIC ACID PLANT

bottom of the Glover tower. Here the ascending SO_2 filters through the broken porcelain saturated with HNO_3 run in from above by means of the dropping funnel. The gas takes up the oxides of nitrogen as evidenced by the dense red fumes, and passes into a Woulff bottle which serves as the first chamber. The middle neck of this bottle, as well as the middle neck of the second chamber, is connected to the boiling flask which acts as steam generator. The steam inlet to the first chamber is fitted with a shut-off, so that water may be excluded and the formation of "chamber crystals" shown. From the first chamber, the gases pass to the second chamber and from there to the bottom of the Gay-Lussac tower. This, like the Glover tower, is a drying tower filled with broken porcelain. It may be saturated with water or dilute sulfuric acid. The outlet on the top of the Gay-Lussac tower is connected to a water aspirator which takes the place of the chimney or stack in the large scale plant. The lower connections of both the Glover and Gay-Lussac towers are fitted with outlets so that the liquids collecting in the reservoirs at the bottom of each may be removed for testing or for transferring to the top of the other.

In operation the aspirator is started, creating a gentle draught of air entering at the open end of the sulfur-burning tube and passing through the apparatus. Burners are placed under the boat bearing the sulfur, and under the steam generator. The heating is continued in the first case only until the sulfur ignites. The steam generator is kept boiling, but as slowly as possible.

It was found that the plant required little attention during the period of a lecture, once the burners and aspirator were suitably adjusted. All chemical and physical changes occurring in the commercial process were illustrated and the student was helped to gain an idea of plant arrangement. Enough sulfuric acid can be made in a fifty-minute period to carry out any tests upon the acid that may be desired.

Coal-Oil Developments in Australia. It is understood (states *The Industrial Australian and Mining Standard*) that an Australian company is shortly to be formed in Sydney for the purpose of undertaking the utilization of coal by-products and for the extraction of oil and other products, such as fertilizers, from coal. Local rights over well-known German processes have, it is stated, been acquired. Both the Federal and State Governments have promised to go into the question of the establishment of an industry along these lines on the coal fields, and it is highly probable that they will give the new enterprise their coöperation. The Prime Minister (Mr. Scullin), when in Sydney recently, was sympathetic in his attitude toward a deputation which urged the establishment of this industry on the Maitland field. Mr. John Fanning, a broker of Sydney, in collaboration with his associate, who is now in Germany, announces that they had been granted a license to use what are known as the I. G. F. processes in Australia for the extraction of oil and other by-products from coal, and that an enterprise on big lines will be established.—*Chem. Age*

A LEEUWENHOECK MICROSCOPE

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For a man not possessed of a scientific education, the discovery of microbes, of capillary circulation of the blood, of red corpuscles in the blood, of spermatic animalcules, of the mischievous effect of the *aphides* upon plant life, of the fibrous structure of the crystalline lens of the eye, the nature of the brain, nerves, hair, and epidermis might be considered a fair life's work. In fact, not a few highly trained scientists of today entrenched in well-equipped laboratories and flanked by well-appointed libraries would be glad to have that number of equally important discoveries to their credit. To Anthony von Leeuwenhoeck these things were just the by-product of a hobby.

His hobby was the making of better microscopes, which in the light of our present knowledge of microscopes, was not a particularly monumental undertaking, for this instrument before Leeuwenhoeck's day was a pretty crude affair consisting of two lenses mounted in metal barrels and having a means by which focusing could be accomplished. As a microscope, the instrument was about as valuable as a pair of cheap opera glasses. Credit for the invention of this optical apparatus is divided between the great early optician, Galileo, and two Hollanders, Hans and Zacharias Janasen, who produced the first crude microscopes some time between 1590 and 1609. For the next fifty or sixty years the microscopes were of low magnifying power and were used principally as toys for the entertainment of people of leisure.

On October 24, 1632, Leeuwenhoeck was born and, as he grew, he developed a natural aptitude for scientific investigation. Everything he was able to lay his hands on was material for study. Plants, tadpoles, fish, crabs, oysters, bugs, their various parts and their parasites, came under his speculating, investigating observation. To learn more about these things, Leeuwenhoeck had to see them better. This required lenses. The lenses commercially available were expensive and none too good. In his search for means of securing greater enlargement, he discovered the magnifying power of the sphere. Perhaps it was through a drop of water hanging from a shrub whose leaf he was studying, but we can imagine him reasoning that a droplet of glass would be more satisfactory. He demonstrated the superiority of single lenses of short focal length over the double lenses then in use and constructed a new type of microscope applying this principle.

The accompanying cut is a photograph of a reproduction of one of Leeuwenhoeck's early microscopes. The original is in the museum of the University of Utrecht. The copy is one of fifteen produced by Dr. L. S. Ornstein, Director of the Physical Laboratory and Curator of the Museum in that institution. It is such a faithful reproduction of the original that, it is said, the original and reproduction could not be differentiated were it not for the inscription, "Copie Utrecht" engraved into the replica. Three

of the copies were brought to the United States by Dr. Ornstein and given to his friends here; the subject of the above cut being the property of A. P. H. Trivelli, microscopist of the Eastman Kodak Company.

The tiny spherical lens, only one millimeter in diameter, will be seen embedded in the body of the microscope directly below the specimen pin. At its widest point the instrument measures hardly more than an inch. Its over-all length is $2^3/_4$ inches while that of the solid portion is about $1^3/_4$ inches. The long screw measures $1^3/_4$ inches. The body is made of two sheets of copper riveted together and pierced at the point where the lens is to rest. This latter is held in place by being inserted between the two sheets in a recess spun into one of them. The specimen to be examined is placed on the needle above the lens and focused by means of the two adjusting screws, one roughly perpendicular to the base of the microscope and the other parallel to it. Thus focusing is accomplished by moving the specimen with respect to the fixed lens instead of vice versa as in our modern instruments.

MODEL OF EARLY LEEUWENHOECK MICROSCOPE

Of the approximately two hundred microscopes Leeuwenhoeck is known to have made, only thirteen remain today distributed among the museums and universities of Europe. In his will he bequeathed to the Royal Society of London, in which he held a fellowship from 1680 until his death in 1723, a cabinet of twenty-six microscopes with magnifying powers of from forty to one hundred sixty diameters. Each had mounted on it a suitable object and a magnified drawing of the specimen accompanied the microscope, the whole being the work of his own hands. Unfortunately, the collection was subsequently dissipated and none of these instruments have been preserved. It is with such crude and simple instruments as the one pictured here that Leeuwenhoeck obtained the data by means of which he refuted the prevalent doctrine of spontaneous generation. He wrote a most interesting article on the flea, describing not only its structure but tracing out the whole history of its metamorphoses from its first emergence from the egg. The contribution is valuable not only for the exactness of his observations, but also for its incidental revelation of the extraordinary ignorance then prevalent in regard to the origin and propagation of "this minute and despised creature," which was variously asserted to be produced from sand, from dust, and from the excrement of birds and animals, but which he

showed was "endowed with as great perfection in its kind as any large animal" and proved to breed in the regular way of winged insects. He even noticed the fact that the pupa of the flea is sometimes attacked and fed upon by a mite—an observation which is said to have suggested the well-known lines of Swift.

Because of the fine example of scientific method and technic which he set in the prosecution of biological research, Leeuwenhoeck well deserves the title "father of scientific microscopy" which has been bestowed upon him. His publications consist of 112 papers in the *Philosophical Transactions* of the Royal Society and twenty-six in the *Memoirs* of the Academy of Sciences of France, to which body he was elected a corresponding member in 1697. His collected works were published in Dutch and in Latin, each in seven volumes, shortly before his death and an abridged edition appeared in English in two volumes about seventy-five years after he died.

Cellulose in the Light of the X-Rays. In his Friday evening discourse on Jan. 24th at the Royal Institution, on "Cellulose in the Light of the X-Rays," Sir William Bragg stated that when a fine pencil of X-rays traverses a fiber of any kind, cotton, hemp, ramie, jute, or such like, the mode of scattering indicates that cellulose is composed, in large part at least, of a mass of small crystals. That the same X-ray diagram is obtained from all fibers, even from animal cellulose, shows that we are dealing always with one and the same substance. It can further be deduced that there is in each crystal a periodicity parallel to the direction of the fiber; and this quantity can be determined exactly. The essential feature of the construction for cellulose suggested by both X-ray and by chemical evidence is the long chain of many links. The bonds that tie the links together are far stronger than those that tie the chain together; those that keep each of the cellulose chains together are as strong as the bonds in the diamond. Indeed, how could a thread carry a suspended weight unless there were great forces in play? But the side-to-side forces are far from being so strong. There seems ground to suppose that bundles of these long chains form "crystallites," small crystalline masses of which the cellulose is largely composed. When the thread is stretched the X-rays show that these bundles go more and more into line. When the stress is too great the bundles begin to slide past one another, and if the force is too great, they let go and the thread breaks.—*Nature*

Lead Arsenate Sprays. In recent years lead arsenate solutions have been extensively used as insecticide sprays, and a leaflet issued by the U. S. Department of Agriculture describes experiments by H. S. Swingle on the effects of such sprays. It was found that, at low concentrations of equivalent arsenic content, arsenious and arsenic acids are equally toxic to peach foliage. At higher concentrations arsenic acid is the more toxic. Arsenic acts as a cumulative poison within peach leaves. The minimum concentration of arsenic acid toxic to peach foliage contains the equivalent of 0.0012 per cent of arsenic pentoxide. Acid lead arsenates containing less than 0.25 per cent of arsenic pentoxide in water-soluble form gave minimum foliage injury. Nothing of practical importance is gained by further reduction in soluble arsenic. Lead arsenate cannot be used upon susceptible plants without the addition of some material to prevent burning.—*Nature*

THE SIXTH CENSUS OF GRADUATE RESEARCH STUDENTS IN CHEMISTRY, 1929

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The Sixth Census of Graduate Research Students in Chemistry, 1929, continues the annual compilation which was first issued in 1924.[1] It is interesting to note the steady growth in the number of students in American universities who are undertaking research in the various fields of chemistry: 1700 in 1924, 1763 in 1925, 1882 in 1926, 1934 in 1927, 2071 in 1928, and 2498 in 1929. The present compilation includes returns from one hundred and thirty-four universities, of which twenty-one have reported members of the faculty only engaged in chemical research.

In compiling the data for the past academic year, a questionnaire was sent to the head of the department of chemistry, with the request that he indicate other departments of his university in which chemical research was being done. To these also questionnaires were sent. This probably accounts for the increase in the number of research workers reported for

TABLE II

Number of Graduate Students Engaged in Research in Various Fields of Chemistry

Subject	1929 *Total*	*M*	*D*	*F*	1928 *Total*	1927 *Total*	1926 *Total*	1925 *Total*	1924 *Total*
General and Physical	448	194	254	227	406	430	343	332	240
Colloid	82	33	49	41	86	79	58	77	69
Catalysis	34	9	25	19	27	28	31	33	51
Subatomic and Radio	20	10	10	15	18	21	21	27	20
Electro-Inorganic	24	9	15	11	25	21	32	42	38
Electro-Organic	15	5	10	12	13	11	13	14	18
Photochemistry and Photography	41	15	26	21	22	25	25	19	24
Inorganic	116	60	56	69	124	116	109	86	101
Analytical	95	54	41	82	96	75	54	44	71
Metallurgical	36	25	11	26	22	21	34	28	38
Organic	719	314	405	250	668	570	475	430	422
Physiological	222	113	109	146	146	134	207	196	172
Pharmacological	14	8	6	31	11	7	14	20	30
Pharmaceutical	27	12	15	20	16	14	21	39	20
Sanitary	27	16	11	17	30	25	11	12	9
Nutrition	80	33	47	44	52	58	51	76	48
Food	31	11	20	18	52	27	37	49	35
Agricultural	91	42	49	94	111	89	72	55	91
Industrial and Engineering	91	54	37	45	156	183	274	184	203
Chemical Engineering	285	183	102	103	..	..	..	..	..
TOTALS	2498	1200	1298	1291	2071	1934	1882	1763	1700

[1] Zanetti, *Ind. Eng. Chem.*, **16**, 402 (1924). Norris, *Ibid.*, **17**, 755 (1925). West and Hull, THIS JOURNAL, **4**, 909 (July, 1927); **5**, 882 (July, 1928); **6**, 1338 (July-Aug., 1929).

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APPEARING AT THE END OF THIS FILM

physiological chemistry and for chemical engineering. It should be noted that this year the separate classification, chemical engineering, has been used for the first time. This was done because of the feeling on the part of certain departments of chemical engineering that their work should not be included under the heading of industrial chemistry. In view of the fact that the data for many universities is a composite of several returns, the name of the head of the department of chemistry, which has appeared in previous compilations, has been omitted from Table I (see insert).

It should be mentioned that in Table II, while a column is given to the faculty, the numbers given there are not included in the totals, as those numbers refer only to the graduate students, and are comparable with the totals for previous years.

An effort has again been made to eliminate the counting of one person more than once. However, it is not always possible to detect such errors of listing, and the compilation is offered with the hope that, in the future, the heads of the various departments will see that this interpretation is strictly followed.

Nature's Legume Crops Select Poorer Soils. When a farmer plants a clover crop on a piece of poor land for the purpose of enriching it, and later on puts the field into some other crop, he is only duplicating a process that happens without human assistance wherever there are raw or impoverished soils. This is indicated by the results of observations by Dr. Elmer Campbell of Transylvania College, published in the scientific journal, *Ecology*.

Dr. Campbell studied a series of raw gravel exposures in Indiana and also a number of exhausted and abandoned fields in various parts of the South. He found that in all cases the larger proportion of legumes in the total vegetation was found on the poorer soils, and that as legumes increased the nitrogen content they were gradually replaced by other wild plants. For instance, on the Indiana gravel he found the plant population to be 100 per cent sweet clover on a three-year-old exposure, but a ten-year-old strip of sweet clover made up only 20 per cent of all the plants present. In the South the predominant wild legume of poor lands was lespedeza.—*Science Service*

New Corn-Waste Chemical 690 Times Sweeter than Sugar. A new sweetening compound which is somewhat sweeter than saccharin and 690 times sweeter than sugar has been prepared by Dr. Henry Gilman and J. B. Dickey of the department of organic chemistry at Iowa State College at Ames from waste products of corn. The name of this compound is "the *syn*-isomer of 5-benzyl-2-furfuraldoxime."

Despite its sparing solubility in water it may become a pattern for new and valuable sweetening compounds. As yet, no study has been made of its physiological action. It is interesting to note that, unlike other artificial compounds of high sweetening power, this compound can be readily prepared from sugar by standard organic reactions. Other raw materials, like paper and cellulosic compounds, in general, can be used as a starting point in its synthesis.

Previously, Dr. Gilman and A. P. Hewlett prepared a compound from corn cobs which was 200 times sweeter than sugar.—*Science Service*

DISTRIBUTION OF GRADES RECEIVED IN GENERAL CHEMISTRY BY THE STUDENTS IN THE VARIOUS SCHOOLS IN THE OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

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This article deals with a study of grades made in chemistry by the students in the six schools in the Oklahoma Agricultural and Mechanical College with the object of determining, *first*, if the students in any school receive higher marks in chemistry than those in the other schools, and *second*, if possible, the causes thereof. The results of two year's study, 1927–29, show that those students in the Engineering school rank first; those in Science and Literature, second; and those in Commerce, Education, and Agriculture, as Osborn found,[1] ranked the lowest. This college is composed of six schools, Agriculture, Engineering, Home Economics, Science and Literature, Education, and Commerce. Chemistry is required of all freshmen in all schools except Commerce. Opportunity for substitution of other sciences is given, and often taken. Owing to the number of students involved the writers believe the results to be representative of the average of the students. The tests used to determine these standings are the Iowa Chemistry Aptitude Examination C*A*-1, Revised *A*,[2] the student's score in the grade given at the close of the semester,[3] the Iowa Chemistry Training Examination C*T*-1, Revised *A*,[4] and the George Washington University General Chemistry Test.[5]

The data is taken from the records made in the scholastic years of 1927–28 and 1928–29. In 1927–28 all students were given the same work regardless of previous training in chemistry or school. But in the second year those students who had had chemistry in high school, and the home economics students were separated into other classes and given other courses. In 1928–29 those who had had high-school chemistry were handled as a separate class, and no report on the performance of these students is included in this paper. The home economics students likewise were handled as a separate class in 1928–29, but were given the two tests, just as were the other freshmen. The regular class took four credit hours of work per semester and the home economics students only three credit hours. Of course, semester grades of these two classes of students are not comparable.

[1] Osborn, R. A., "First-Year College Chemistry and Students from the School of Agriculture," THIS JOURNAL, **6**, 2189–95 (Dec., 1929).

[2] Cornog, J., and G. D. Stoddard, "Predicting Performance in Chemistry," *Ibid.*, **3**, 1409 (Dec., 1926).

[3] Smith, O. M., and Trimble, H. M., "Prediction of Future Performance of Students from Their Past Records," *Ibid.*, **6**, 93–7 (Jan., 1929).

[4] Cornog, J., and G. D. Stoddard, "The Chemistry Training of High-School and College Students," *Ibid.*, **6**, 85–92 (Jan., 1929).

[5] Moss, F. A., Wm. Loman, and T. Hunt, "Impersonal Measurements of Teaching," *Educ. Record*, **10** (Jan., 1929).

In the year 1928–29 the class, at the close of the year's study, was divided, and part given the Iowa Training Examination, and part the George Washington University Chemistry Test. This accounts for the smaller number of students taking these tests in 1928–29.

The norms accepted are those given in the latest direction sheets accompanying these examinations, namely:

Test	*CA*-1 Rev. *A*	*CT*-1 Rev. *A**	Geo. Wash. Univ. Chem. Test
No. cases	5917	474	3584
Median	53	81	56
Upper quartile	59	103	For those students who have had but one year of college chemistry and no high-school chemistry.
Lower quartile	38	63	

* For college chemistry.

The other measures were the actual scores received in the first and second semester grades. These scores were obtained from monthly written tests, daily, and laboratory grades.

The general chemistry course consists of two hours of lecture and one afternoon of three hours' laboratory .work followed by an hour of quiz. In the first laboratory period the aptitude test was given, and from the results of this test the group, varying from 100 to 200 coming on an afternoon, was sectionized according to the score into groups of not more than 30 students. The sectionization the second semester was made upon the basis of grades received the first semester. All students received the same treatments, quizzes, and tests, but, in general, those from the different schools were in groups to themselves. No effort was made to give different work except that illustrative material in the lectures was that with which the student was probably most familiar. The greatest difference is that between the two years, for in the second year the home economics students are not present, nor those who had high-school chemistry.

TABLE I

Relative Standing of Students from Various Schools Who Took General Chemistry in 1927-28

Chem. Aptitude *CA*-1, Rev. *A*			First Semester		Second Semester		Chem. Training *CT*-1, Rev. *A*	
Rating	*School*	*Median*	*School*	*Median*	*School*	*Median*	*School*	*Median*
	Norms	53					Norms*	81
1	Engineering	46	Engineering	59	Engineering	47	Engineering	90
2	Science and Literature	41	Science and Literature	57	Education	45	Commerce	81
3	Education	37	Agriculture	55	Commerce	45	S. and L.	78
4	Home Econ.	37	Commerce	55	S. and L.	44	Agriculture	67
5	Commerce	35	Education	54	Agriculture	43	Education	63
6	Agriculture	35	Home Econ.	53	Home Econ.	41	Home Econ.	63
	All students	40		56		44		75

* For college chemistry.

TABLE II

Relative Standing of Students from Various Schools Who Took General Chemistry in 1928-29

Rating	Chem. Aptitude *CA*-1, Rev. *A* School	Median	First Semester School	Median	Second Semester School	Median	Chem. Training *CT*-1, Rev. *A* School	Median	Geo. Washington General Chem. School	Median
	Norms	53					Norms*	81	Norms**	56
1	Engr.	43	Engr.	52	S. & L.	45	Engr.	83	Engr.	45
2	S. & L.	40	S. & L.	52	Educ.	45	S. & L.	77	Com.	43
3	Com.	36	Educ.	51	Engr.	45	Com.	73	Educ.	39
4	Agri.	34	Agri.	52	Com.	46	Agri.	69	Agri.	36
5	Educ.	33.5	Com.	50.5	Agri.	42.5	Educ.	69	S. & L.	33
6	H. Ec.	31					H. Ec.	63		
All students		37		52		45		72		39

* For college chemistry.

** No high-school chemistry and one year of college chemistry.

Comparison is made by means of the median score. When the scores were the same or very close, placing was determined by considering the other two quartile scores.

The data in Table I and II show that the engineering and science and literature students consistently hold first and second rank and that home economics and agriculture students were the lowest in 1927–28. The following year home economics students again rated low in the Aptitude

TABLE III

Relative Standing of the Students from the Various Schools Who Completed the Course of General Chemistry

1927–28

Rating	Chem. Aptitude *CA*-1, Rev. *A* School	Median	First Semester School	Median	Second Semester School	Median	Chem. Training *CT*-1, Rev. *A* School	Median
	Norms	53					Norms	81
1	Engineering	52	Engineering	63	Engineering	47.5	Engineering	87
2	Science and Literature	47	Science and Literature	62	Commerce	46.5	Commerce	81
3	Commerce	45	Commerce	59	S. and L.	46	S. and L.	76
4	Home Econ.	42	Education	58	Agriculture	45	Agriculture	71
5	Agriculture	42	Agriculture	57	Education	45	Education	67
6	Education	42	Home Econ.	56	Home Econ.	40	Home Econ.	65.5
	All students	45		60		45		75

1928–29

Rating	Chem. Aptitude *CA*-1, Rev. *A* School	Median	First Semester School	Median	Second Semester School	Median	Chem. Training *CT*-1, Rev. *A* School	Median
	Norms	53						
1	Engineering	46.5	S. and L.	56	S. and L.	46		
2	S. and L.	42	Engineering	56	Engineering	46		
3	Agriculture	41	Agriculture	53.5	Education	45		
4	Commerce	39	Commerce	53	Commerce	46		
5	Education	36	Education	51	Agriculture	43		
	All students	42		53		45		

TABLE IV

Number of Students Tested

	Year—1927–28				Year—1928–29				
	Chem. aptitude *CA*-1	First semester	Second semester	Chem. training *CT*-1	Chem. aptitude *CA*-1	First semester	Second semester	Chem. training *CT*-1	George Washington, Gen. Chem.
Engineering	199	182	132	132	158	127	104	53	46
Science and Lit.	150	133	111	94	143	118	81	41	43
Education	152	143	96	96	86	78	72	21	26
Commerce	106	86	63	62	103	71	49	24	31
Agriculture	82	73	70	62	107	84	76	49	53
Home Econ.	101	96	78	74	97			69	
All students	790	713	550	520	694	478	382	257	199

Examination, but since they received 25% less training would naturally place the lowest in the Training test. The data the second year, though clearly indicative as to the first and second place, is not sufficient to place any one school as consistently the lowest.

TABLE V

Comparison of Scores Received with Norms in the Iowa Aptitude Examination *CA*-1, Rev. *A*

	1927–28 Quartile				1928–29 Quartile			
School	*Cases*	*Upper*	*Median*	*Lower*	*School*	*Cases*	*Upper*	*Median*	*Lower*
Norms	5917	69	53	36	Norms	5917	69	53	38
Engineering	199	49	46	34	Engineering	158	53	43	33
Sci. and Lit.	150	55	41	28	Sci. and Lit.	143	49	40	29
Commerce	106	50	35	26	Commerce	103	47	36	28
Agriculture	82	46	35	21	Agriculture	107	49	34	21
Education	152	48	37	26	Education	86	44	33.5	26
Home Ec.	101	46	37	28	Home Ec.	97	42	31	21
All students	790	52	40	28	All students	694	48	37	21

TABLE VI

Median Score Received in Each Part of *CA*-1, Rev. *A*, Examination by Students from the Various Schools in 1927-28

		Parts							
		I		II		III		IV	
Rating	*Cases*	*Arithmetic*		*Reading Ability*		*Reading and Selective Ability*		*General Information*	
	573*		18.53		15.72		24.00		7.40
1	199	Engr.	14.23	Engr.	12.42	S. & L.	18.21	Engr.	5.93
2	144	S. & L.	10.70	S. & L.	10.89	Engr.	16.94	Com.	4.50
3	97	Com.	10.46	Com.	10.50	H. Ec.	16.80	S. & L.	4.26
4	100	H. Ec.	10.38	H. Ec.	9.60	Educ.	16.07	Agri.	4.18
5	150	Educ.	10.29	Educ.	9.57	Com.	14.11	Educ.	3.77
6	79	Agri.	8.71	Agri.	9.00	Agri.	12.75	H. Ec.	3.17
All students	790		10.7		10.4		16.3		4.4

* Personal information from C. D. Stoddard, May 1, 1929.

TABLE VII

Summary of Performance with the Iowa Aptitude Examination *CA*-1, Revised *A*

Given at the beginning of the course

Year	Cases	Q_1	Q_2	Q_3	Part I Q_1	Part I Q_2	Part I Q_3	Part II Q_1	Part II Q_2	Part II Q_3	Part III Q_1	Part III Q_2	Part III Q_3	Part IV Q_1	Part IV Q_2	Part IV Q_3	Remarks
1926	831	28	38.5	50	6	10	16	6	10	13	8	14	20	2	4	6	No students with H.-S. Chemistry
1927	790	28	40	52	6.6	10.7	16.2	6.3	10.4	14.4	10.5	16.3	20.8	2.9	4.4	6.8	Includes students with H.-S. Chem.
																	193 cases on parts of test
1928	694	21	37	48													No students with H.-S. Chemistry
1929	566	29	41	53													No students with H.-S. Chemistry
Norms					13.7	18.5	23.8	11.7	15.7	18.5	19.6	24.0	27.3	5.6	7.4	9.6	Probably high since Med. has dropped 60 for 2032 cases to 43 for 5917 cases

Q_1—Highest score in the lower one-fourth of the class.
Q_2—Median score.
Q_3—Highest score made by three-fourths of the class.

Admitting these findings, some educators have affirmed that there is no class or school difference as regards chemistry between students if we consider only those who complete their freshman work. In order to determine the validity of this statement, median scores were obtained on those who completed the year's work; these results are tabulated in Table III. Here again practically the same relative order is observed, the highest being the engineering and science and literature students, but the data is not very definite as regards the other schools. Home economics, education, agriculture, and commerce seems to be the position as to the poorest performance.

In Table IV the number of students involved is given. The number is sufficient to be representative except in the *CT*-1, Rev. *A* and George Washington tests in 1928–29.

In order to determine reasons for this consistent performance a study of the aptitude test was made. This examination tests in four skills: arithmetic, reading ability, reading and selective ability, and general information of a scientific nature. It is designed only to test and predict a pupil's ability to study chemistry.

In Tables V, VI, and VII the engineers ranked first in all tests except reading and selective ability; the science students ranked

second in arithmetic and reading, first in reading and selective ability, and third in general information. The agriculture students were the lowest, ranking sixth in all except general information, where they ranked fourth, and the education students ranked fifth in all except reading and selective ability. These results are just what one might expect, knowing the interests of these students.

There is one striking difference between the education, commerce, and literature students, and those in the other groups. It is this, these students take chemistry as a required science, and do not use it as a foundation course for other work as is the case of the agriculture, home economics, and engineering students. The science student elects it, hence should perform better.

TABLE VIII

Comparison of Scores Received with Norms for Colleges in the Iowa Chemistry Training Examination *CT*-1, Rev. *A*

	1928-29					1929-30			
		Quartile					Quartile		
School	*Cases*	*Upper*	*Median*	*Lower*	*School*	*Cases*	*Upper*	*Median*	*Lower*
Norms	474	103	81	63	Engineering	119	117	99	86
Engineering	53	100	83	73	Commerce	16	116	98	81
Science and Literature	41	100	77	59	Science and Literature	51	113	94	72
Commerce	21	89	73	68	Agriculture	63	107	86.5	71
Agriculture	24	83.5	69	56	Education	52	101	79	66
Education	49	62	69	54	All students	301	112	93	75
Home Economics*	69*	79	63	25					
All students	188**	98	76	60					

* Not included in total or average.

** Total number of students included.

One question may be raised: What would be the result if the chemistry texts were written and the courses taught by individuals with a type of mind and aptitudes as ascribed to the agriculturist, the home economics, and educational expert? The writers can see no reason why the results would not be the same.

It is clearly evident from the examination of this data that the students coming to Oklahoma Agricultural and Mechanical College are below the average in their preparation in arithmetic, reading, reading and selective ability, and general information of a scientific nature.

This past year more careful selection of students has been made—so that this year (1929–30) these students were able to score in the Iowa Training Test obtaining a ranking above the norms given by Cornog and Stoddard. This improvement is shown in Table VIII.

Considering the handicap imposed by the presence of such a great number of poorly prepared students a very good relative showing is made (see

Table VIII) by the engineering and science and literature students, which group includes those majoring in chemistry and chemical engineering.

Conclusions

(1) It is clearly evident that there is a marked difference in the performance in chemistry by the students in the different schools and that engineering and science and literature students rank higher than the others.

(2) Evidence is not sufficiently definite to place the other schools.

(3) In preparation, as in performance, the engineers and science and literature students are best, while the agriculture and home economics students are the poorest.

(4) Performance in college chemistry in this school appears to depend largely upon the aptitude of the students and their prior preparation in high and grade schools.

Artificial Snowflakes. The first artificial snowflake ever made by man has been produced in Los Angeles, a city which almost never sees natural snow, by Prof. John Mead Adams, of the University of California's Los Angeles laboratory, and is reported by him to the American Physical Society.

Ordinary methods of freezing samples of fog or of cooling water sprays or moist air do not produce snowflakes but only frost crystals, hailstones, or other bits of ice. How to form the beautiful lacy structure of snowflakes has been one of Nature's secret processes, carried out only in the upper air.

After ten years' work, Professor Adams has perfected an apparatus in which real snowflakes can be produced, although they are microscopic in size, the largest measuring less than one-ten thousandth of an inch. A stream of cold dry gas from evaporating liquid air passes into a cold chamber also supplied with a stream of cold moist air only a degree or two above the freezing point of water, but hundreds of degrees warmer than the stream of dry gas from the liquid air.

When the super-cold dry gas from the liquid air meets the cold but moist stream of ordinary air, thousands of very tiny snowflakes are produced. Some of these can be caught on an illuminated glass plate and watched under a microscope. A part of them grow larger at the expense of their smaller fellows, a cannibalistic process believed to happen also in the upper air when natural snowflakes are produced.—*Baltimore Sunday Sun*

Dead Sea Potash. In an interview Dr. S. Van Vriesland said that it was first intended to extract potash from the Dead Sea, then bromide, and eventually, when transport facilities are adequate, it might be possible to produce common salt on a commercial scale. At present transport was by road, and before the work could be fully developed a railway down the Jordan Valley would be needed. The salt water was run into shallow pans and left in the sun to evaporate, a method that will be used when the work is developed, but the pans at present were for experimental purposes only. Dr. Novomeysky, who formed the company, had been working at the Dead Sea for nearly 20 years, and recent tests had been extremely satisfactory. The potash would be used largely for fertilizer in Palestine.—*Chem. & Ind.*

A REPORT OF FRESHMAN CHEMISTRY LABORATORY ADMINISTRATION

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In order to ascertain what was considered as necessary equipment to be placed in freshman laboratory outfits, as non-returnable, as well as returnable, a questionnaire was submitted to a group of large universities. Questions were also asked as to charges for chemicals, use of laboratory currency, stockroom accounts, and other problems of stockroom administration.

As a result of the answers submitted by these institutions

1. Chicago, University of
2. Cincinnati, University of
3. Columbia University
4. Harvard University
5. Illinois, University of
6. Iowa State University
7. Nebraska, University of
8. Northwestern University
9. Ohio State University
10. Purdue University
11. Southern California, University of
12. Syracuse University
13. Pennsylvania, University of
14. Wisconsin, University of

the data were tabulated in the following report.

Laboratory Supplies

I. Number of institutions supplying material as:
   (A) Returnable (used as a loan)
   (B) Non-Returnable (purchased by student).
II. Number of institutions not supplying material.

ARTICLE	No.	SIZE	IA	IB	II
Balance	1		1	0	12
Beakers	3	1 nest (50–1000)	2	0	
Beakers	4	1 nest (50–1000)	4	0	
Beakers	5	1 nest (50–1000)	4	0	0
Beakers	6	1 nest (50–1000)	1	0	
Beakers	7	1 nest (50–1000)	1	0	
Beakers	10	1 nest (50–1000)	1	0	
Blow pipe	1		2	0	11
Board transit	1		1	0	12
Boat—porcelain	1		4	0	9
Borer, cork	1		2	1	11
Bottles, vial mouth	1	(90–1000)	3	0	9
Bottles, vial mouth	4	(90–1000)	1	0	
Bottles, salt mouth	3	(250–500)	2	0	5
Bottles, salt mouth	4	(250–500)	6	0	
Brush—test tube	1		2	9	2
Brush—funnel	1		1	0	12
Buret—plain	1		1	0	11
Buret—plain	2		1	0	
Burners	1		6	0	2
Burners	2		4	1	
Burner, wing top	1		11	2	0

ARTICLE	No.	SIZE	IA	IB	II
Casserole	1		3	0	9
Casserole	2		1	0	
Charcoal block	1		1	0	12
Clamp—buret	1		8	1	3
Clamp—buret	2		1	0	
Clamp—pinch	1		5	1	5
Clamp—pinch	2		2	0	
Clamp—screw	1		2	1	10
Clamp—test tube	1		8	2	3
Crucible and lid	1		5	2	1
Crucible and lid	2		4	1	
Cylinder, graduated	1	(25–100 cc.)	8	0	1
Cylinder, graduated	2	(25–100 cc.)	4	0	
Desiccator	1		1	0	12
Dishes—evaporating	1	Assorted (5–12 cm.)	5	0	
Dishes—evaporating	2	Assorted (5–12 cm.)	5	0	2
Dishes—evaporating	3	Assorted (5–12 cm.)	1	0	
Dishes—iron	1		0	1	12
Dishes—lead	1		1	1	11
File—round	1		1	4	8
File—triangular	1		2	9	2
Flasks, Erlenmeyer	1	(100–250 cc.)	4	0	
Flasks, Erlenmeyer	2	(100–250 cc.)	1	0	6
Flasks, Erlenmeyer	4	(100–250 cc.)	2	0	
Flasks, filter	1		2	0	11
Flasks, Florence	1	(100–1000)	2	0	
Flasks, Florence	2	(100–1000)	5	0	0
Flasks, Florence	3	(100–1000)	5	0	
Flasks, Florence	5		1	0	
Forceps—pair	1		6	1	6
Funnels	1		4	0	
Funnels	2		7	0	1
Funnels	3	Including Hirsch	1	0	
Funnels, separating	1		3	0	10
Gauze, wire	1		2	8	1
Gauze, wire	2		0	2	
Goggles	1		1	0	12
Knife and case	1		1	0	12
Litmus-paper (pkg.)	1		0	2	6
Litmus-paper (pkg.)	2		1	4	
Lock and key	1		7	0	5
Matches—box	1		1	6	4
Matches—box	2		0	1	
Mortar and pestle	1		13	0	0
Paste tube	1		0	1	12
Pan—granite	1		2	0	11
Paper—filter	1	Assorted $\frac{1}{2}$–1 pkg.	1	10	2
Paper—pad	1		1	0	12
Plate—blue glass	1		4	0	9
Plate—glass	1		1	0	

ARTICLE	No.	SIZE	IA	IB	II
Plate—glass	3		1	0	2
Plate—glass	4		7	0	
Plate—glass	5		1	0	
Pipet	1	10 cm.	1	0	12
Platinum wire and holder	1		1	0	12
Reagent bottles	4		1	0	
Reagent bottles	8		1	0	10
Reagent bottles	9		1	0	
Retort—glass	1		1	0	12
Rings, iron	1	(2–5″)	2	0	
Rings, iron	2	(2–5″)	2	0	8
Rings, iron	3	(2–5″)	1	0	
Rod—light glass	10 ft.		0	1	
Rod—light glass	2½ ft.		1	1	
Rod—light glass	2 ft.		0	1	4
Rod—light glass	1 ft.		1	0	
Rod—light glass	2 oz.		0	2	
Rod—light glass	2 rods		2	0	
Sand bath	1		2	0	11
Soap—bar	1		0	2	11
Spatula—porcelain	1		9	0	4
Splints	50		0	1	12
Sponge	1		3	6	4
Spoon—deflagrating	1		8	1	4
Square asbestos	1		1	0	12
Stand—ring	1		5	0	8
Stoppers—corks	(5–25)	Assorted	2	2	9
Stoppers—rubber	(4–5)	Assorted	1	2	10
Supply pads	2		1	0	12
Support—funnel	1		6	0	7
Support—test tube	1		9	0	4
Thermometer	1		6	0	7
Tongs, crucible	1 pair		8	0	5
Towel	1		0	7	5
Towel	2		0	1	
Triangle—clay	1		6	1	5
Triangle—clay	2		1	0	
Triangle—wire	1		4	1	8
Tripod	1		1	0	12
Trough—pneumatic	1		3	0	10
Tube, drying	1		6	0	7
Tube, hard glass	1	30 cm.	2	1	10
Tube, test, hard glass	1		5	0	
Tube, test, hard glass	2		4	0	1
Tube, test, hard glass	3		2	0	
Tube, test, hard glass	4		1	0	
Tube, thistle	1		11	0	2
Tubes, small test	8		2	0	
Tubes, small test	10		6	0	0
Tubes, small test	12		5	0	

ARTICLE	No.	SIZE	IA	IB	II
Tubes, large test	1		2	0	
Tubes, large test	2		2	0	7
Tubes, large test	3		1	0	
Tubes, large test	12		1	0	
Tube, test, side neck	1		1	0	12
Tube, U—side arms	1		5	0	8
Tubing, glass	3½ ft.		1	0	
Tubing, glass	5 ft.	6 mm.	0	3	
Tubing, glass	6 ft.	6 mm.	1	1	
Tubing, glass	7 ft.	6 mm.	1	1	2
Tubing, glass	10 ft.	6 mm.	0	1	
Tubing, glass	50 g.	6 mm.	0	1	
Tubing, glass	17 ft.	6 mm.	0	1	
Tubing, gas rubber	1 piece		3	0	
Tubing, gas rubber	2 ft.		0	1	
Tubing, gas rubber	3 ft		0	2	5
Tubing, gas rubber	6 ft.		1	0	
Tubing, gas rubber	9 ft.		0	1	
Tubing, rubber maroon	Less than 1 ft.		2	1	
Tubing, rubber maroon	1 ft.		0	5	4
Tubing, rubber maroon	18 in.		1	0	
Watch glasses	1	50–100 mm.	3	0	
Watch glasses	2	50–100 mm.	4	0	1
Watch glasses	3	50–100 mm.	3	0	
Watch glasses	4	50–100 mm.	2	0	
Weights, set of	1		3	0	10
Wire, copper	1		0	1	12

Additional Data

1. *Do you use combination or key locks and do the students purchase or are they loaned such locks?*

   Answers: key lock loaned (9); purchased (2); either or both loaned (3).

2. *How much is added to the cost to determine sales price of apparatus or equipment?*

   Answers: nothing (3); 10% (6); 15% (2); not over 25% (2); no answer (1).

3. *Does the stockroom lend equipment or is there a separate service for this purpose?*

   Answers: loaned by stockroom only (13); separate service only (0); both of above (1).

4. *Does the stockroom charge for chemicals and reagents?*

   Answers: yes (5); no (7); yes, but not for freshmen (1); yes, for alcohol, ether, CCl_4, etc. (1).

5. *Does the stockroom maintain a running charge account for each student or does it use some form of coupon on purchasing system?*

   Answers: running charge account (9); coupon system (5); contemplate use of coupon system (1).

6. *If a coupon system is used, what is the initial investment asked of the student?*

   Answers: $2.50 (1); $2.00–5.00 (contemplated) (1); $5.00 (2); $7.00–10.00 (1); $15.00 (1).

7. *What laboratory fees are freshmen students charged for the use of laboratory sets and desks?*

Answers: nothing (4); $3.00 (1); $4.00 (1); covered by tuition (1); 45–50% fees (1); $10.00 per quarter (1); $14.00 per semester (1); $12.20 (1).

8. *What reserve or non-expendable deposit is a student required to make to assure payment of breakages at the close of the year?*

Answers: none (4); $2.00–5.00 (1); $2.50 (1); $5.00 (2); $5.00 per course (1); $5.30 (1); $10.00–30.00 per course (1); $25.00 (1); bond (1).

9. *Is a student responsible for ordinary wear and tear on the equipment (especially wood and metal apparatus)?*

Answers: yes (3); no (10); yes, above 50¢ (1).

10. *Is the student charged with full cost of breakage of expensive or special apparatus?*

Answers: yes (10); no (2); just for repairs (1); no, except for carelessness (1).

11. *Are students permitted to borrow equipment without an order from their instructor?*

Answers: yes (7); no (5); yes, except freshmen (1); both, yes and no (1).

12. *Do you lend equipment to students over extended periods of time?*

Answers: yes (13); no (1).

13. *What system is used for insuring that loaned equipment will be returned on time and in good condition?*

Answers: none (2); damage and rental charge (1); fine (4); rental charge (1); checked at intervals (2); deposit covers loan (1); loan books (1); supervision of use (1).

Production of Tantalum, Rarer than Gold, Increases. Strange tantalum, the metal rarer than gold, which absorbs 740 times its volume of hydrogen gas, successfully resists attack by the strongest mineral acids, and changes alternating into direct current, is finding greater use for dental instruments, surgical tools, pen points, hypodermic needles, and acid-proof pumps, Prof. George W. Sears, of the University of Nevada, recently reported to the American Institute of Mining and Metallurgical Engineers.

Even though tantalum was used for electric light filaments in 1906, until the past few years it has been only a rarity. It forms a much smaller portion of the earth's crust than gold, it is estimated. The production in 1928 was 35,000 pounds. Because it absorbs gas so well, it is used for the metal parts of vacuum tubes. Although there are other substances, which when used as an electrode of an electrolytic cell permit the passage of electricity in only one direction, tantalum is the best, said Prof. Sears. Electrolytic rectifiers for charging storage batteries contain it. "Aqua regia, which readily dissolves both platinum and gold, has no action on this metal," continued Prof. Sears. Hydrofluoric is the only acid successful in attacking it. Strong alkalies have no effect on it. Tantalum can be cold rolled to a sheet one-thousandth of an inch thick. It is found in the Black Hills of South Dakota and in Australia.—*Science Service*

Little Danger of Carbon Monoxide Poisoning in Large Garages. Little danger of carbon monoxide poisoning was found in multi-story garages in experiments conducted by W. C. Randall and L. W. Leonhard, Detroit engineers. The greatest concentration of the gas found in large garages during many tests is only sufficient to cause attendants to have headaches.

A fast running motor exhausts between one and one and a half cubic feet of carbon monoxide every minute. The concentration in multi-story garages, however, was found never to exceed one and a half parts in 10,000, and this only during rush hours.

Even in cold weather, when ventilation is limited, this type of garage is large enough to hold the excess gas without dangerous concentration, and the movement of cars keeps it stirred up and prevents pocketing, the two engineers reported.—*Science Service*

Correspondence

OXIDATION-REDUCTION EQUATIONS

MY DEAR MR. REINMUTH:

Your recent articles in the JOURNAL dealing with oxidation-reduction reactions are not only thought-provoking but, as I hope you will find, correspondence-provoking also. It seems to me that you have outlined the subject on the basis of the theory of atomic structure in a very satisfactory way. My personal reaction is favorable—on the whole. But certain points in connection with your reply to the inquiry by C. A. G. in the May issue lead me to write to you in a somewhat controversial spirit.

Frankly, I do not believe that you are in accord with the majority of teachers of chemistry who have to teach oxidation-reduction reactions and who at the same time have tried to keep in touch with the modern trends of theory as applied to this most difficult type of reactions with which elementary or second-year students have to deal. My contentions, made in the interests of chemical education, are these.

First. On page 1182 of the May number of the JOURNAL you state: "The fact is that $KMnO_4$ does not yield 'nascent' (or atomic) oxygen." Mr. Editor, your evidence? As a matter of *opinion* I agree with you but searching of the literature has failed to produce the desired *evidence.* In fact, the evidence, as far as it goes, is against us; $KMnO_4$ in the presence of fairly concentrated sulfuric acid *does* yield oxygen. Other teachers of chemistry besides myself would be gratified, I am sure, to have some real, convincing evidence that the same thing may not happen at all in more dilute solution.

Second. The JOURNAL OF CHEMICAL EDUCATION has weighty influence among teachers of chemistry; it is regarded as authoritative. Lest your personal preference in avoiding assigning valences to the individual atoms in an ion be regarded by readers of the JOURNAL as an official pronouncement of the Division behind the JOURNAL, let me be one to register opposition to your views on the matter. We assign valence to carbon in writing the structural formula of acetic acid used in teaching organic chemistry; why not retain that valence when dealing with the acetate ion? We assign valence to sulfur when we explain the formation of sulfuric acid from sulfuryl chloride and water; why not retain it when dealing with the sulfate ion? Why should we go consciously out of our way to avoid assigning valences to the atoms in an ion when those same avoided valences must be assigned to deal intelligently with the molecule in which the valence forces must be substantially the same? Why not assign valence to the Mn in MnO_4^-?

Third. The reaction between ferrous sulfate and potassium permanganate in the presence of sulfuric acid would be represented, if I am not mistaken, according to your method, by:

$$(1)\quad 5Fe^{++} \longrightarrow 5Fe^{+++} + 5\epsilon$$
$$(2)\quad MnO_4^- + 8H^+ + 5\epsilon \longrightarrow Mn^{++} + 4H_2O$$

Reaction (1) probably represents the real mechanism; the fact that the oxidation of the ferrous ion may be accomplished with salt bridge and wire connection is evidence of this. Reaction (2) may be correct as a "summed up" reaction but as a representation of the mechanism it is unnecessarily complex and it is not the most reasonable—it implies that the reaction is of the ninth order—that reduction of the MnO_4^- may take place only when "bombarded" simultaneously by eight H^+ ions in the presence of the available electrons.

Is it not more reasonable and more logical—and it is certainly simpler—to assume the existence of heptavalent manganese ions? With this assumption the reaction comes down to this:

$$(1)\quad 5Fe^{++} \longrightarrow 5Fe^{+++}$$
$$(2)\quad MnO_4^- \rightleftharpoons Mn^{+7} + 4O^{--}$$
$$+$$
$$8H^+$$
$$\Updownarrow$$
$$4H_2O$$
$$Mn^{+7} + 5\epsilon \longrightarrow Mn^{++}$$

Modern chemists generally believe in the near-universality of equilibria in solutions; they believe that even nitric acid and sulfuric acid may yield some OH^- in aqueous solution; they believe that in the ionization of water itself, relatively slight as it is, there is some secondary ionization yielding O^{--}. We *know* that Mn_2O_7 exists. Why not then assume the existence of heptavalent Mn ion, the equilibrium tending strongly to the MnO_4^- side? Also is it not generally believed that when water forms in solution from H^+ it does so by union with OH^- or O^{--}?

So it seems to me that in the interests of chemical pedagogy you should give publicity in some manner or other to this other view which I am firmly convinced will be in closer accord with the views of those actually teaching the subject. This mechanism is more readily visualized by the student, is infinitely simpler to teach and, more important than either of these, it is probably a more nearly correct picture of the actual mechanism.

W. B. MELDRUM

HAVERFORD COLLEGE
HAVERFORD, PENNSYLVANIA

* * * * *

DEAR DR. MELDRUM:

Your letter is representative of a number of comments called forth by the correspondence on oxidation-reduction in the May JOURNAL (pp. 1180–4).

At least one of the criticisms advanced is well founded and I shall acknowledge it in more detail. Others, it seems to me, are based on misconceptions. These also it seems worthwhile to discuss briefly, for the sake of removing false impressions.

It may not be amiss to begin by saying something of the policies of the JOURNAL—not from the standpoint of one who is empowered to make official pronouncements on the subject, but from that of one who has had somewhat more than average opportunity to observe those policies in operation. It is, then, my personal and private understanding that the JOURNAL is not supposed, either by its staff, its sponsors, or its readers, to be *authoritative* in the sense that any and all opinions and preferences expressed in its columns are to be accepted without question as gospel. Personally, I believe, or at least hope, that the members of the Division of Chemical Education and other readers of the JOURNAL expect the staff to exercise all due diligence, and to employ the services of reviewers when necessary, to avoid publishing statements contrary to fact. There has never been, so far as I am personally aware, any demand from any source for an editorial censorship of opinion. It is my private notion that any such censorship would be highly undesirable, and I will undertake to demonstrate upon demand that it would be impracticable.

Freedom of opinion in matters not yet submissible to rigorous experimental investigation seems to me, therefore, to be one of the policies of the JOURNAL, and one which applies with particular force to the correspondence columns. If this policy is to be applied to contributors in general, it must, I think, apply equally to members of the JOURNAL staff who contribute under their own signatures. No individual employed by the JOURNAL automatically becomes infallible thereby. Perhaps I may be permitted to doubt privately that the JOURNAL could locate and employ infallible individuals, and so receive the benefit of their infallibility. Hence, the opinion of a member of the staff, *as such*, is worth precisely as much or as little as that of any other contributor, *as such*.

It follows, therefore, that my advocacy of the electronic method of balancing oxidation-reduction is based on a personal preference (in which, by the way, the editor-in-chief does not concur). What that abstraction which we have been calling the JOURNAL may think of it, I am not prepared to say.

I would not leave the impression that this preference is a matter of whim or caprice. It is, in fact, predicated upon my conception of the proper objectives of a course in elementary chemistry, which is, in turn, based on my philosophy of education (*i. e.*, upon my beliefs as to what it is possible and desirable for education to accomplish). While none of these fundamental convictions of mine is, I hope, the result of a pure act of faith, any ultimate decision arising out of them must involve a large element of personal judgment.

Obviously a method of instruction can have no intrinsic merits or advantages. It must stand or fall by reason of its effectiveness in attaining certain objectives and by reason of the worth of those objectives. What little I shall have to say in favor of the electronic method in answer to your questions will of necessity, therefore, be suspended in thin air.

With this understanding, I may begin by saying (as a matter of personal opinion) that the concept of valence is a troublesome vestigial appendage surviving from a comparatively primitive stage in the development of chemistry. It is a matter of demonstrable fact that the term has outlived its necessity; it is my personal opinion that it has largely outlived its usefulness save as a linguistic convenience. In the light of our present knowledge it would be entirely possible, and I think desirable, to write a thorough and comprehensive text on elementary chemistry without employing the term at all. There is not, to my knowledge, any phenomenon in which the empirical abstraction known as valence can be legitimately and helpfully applied, which does not lend itself to more concrete and fundamental discussion in terms of electrons, shared or transferred.

Instead of making a clean sweep of the superfluous concept of valence, we all do one of two things. We either ignore electrons and protons as much as possible and continue to teach in terms of valence, or we attempt to compromise by going the long way around and showing how valence can be interpreted in terms of electrons.

The first method seems to me reactionary, the second leads to difficulties. These difficulties are never more apparent than when we attempt to recast our various so-called "definitions" of valence in terms of electrons. Aside from the inherent impossibility of truly defining any abstraction in concrete terms, we are faced by the fact that this particular word does duty in a number of different senses. I shall not labor this point, but I invite you to prayerful consideration of the sixteen "definitions" of valence recently compiled from sixteen widely used high-school texts by Professor J. O. Frank.[1]

As I have already intimated, it would be my personal inclination to pick the concept of valence up by the scruff of the neck with a long pair of tongs and drop it overboard and out of elementary chemistry entirely. Those students who survived the first year and came back for more chemistry would receive a heart-to-heart talk on the subject purely for the purpose of enabling them to read the literature intelligently.

Since it would generally be considered indefensible to follow so radical an inclination, I have not abandoned the concept entirely but have preferred to do my reasoning and explaining in terms of the more concrete and fundamental electron.

[1] THIS JOURNAL, **5**, 1476–9 (Nov., 1928).

Jette and La Mer[2] have discussed the advantages of the electronic method of equation-balancing at some length and I shall not quote them in full here. Two points are worthy of emphasis however. The first is that this method emphatically does not (as you erroneously suppose) imply anything whatever about the mechanism of the reaction. It deals only with initial reactants and final products and it includes nothing more imaginary than electrons. This, it seems to me, is one of the chief merits of the system. It assumes neither Mn^{7+}, Cr^{6+}, N^{5+}, 0^{2-}, nor nascent oxygen. As long as we know so little as we do about the mechanisms of many reactions, it is idle to talk of giving the student a "correct picture of the actual mechanism." If, as I surmise, you really meant to write "a more reasonable picture of the actual mechanism," you again introduce a matter involving widely varying personal opinions. To me, personally, Mn^{7+} is not very reasonable."

The second point to be taken into account is that it enables one to deal quickly and simply with some reactions which are very difficult and tedious to handle by any valence-change method, no matter how arbitrary and far-fetched the assumptions one permits himself. I cite an example offered by Jette and La Mer:

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$$

Therefore I hesitate to assign valences to constituent atoms in compound ions when dealing with oxidation-reductions, firstly because it is entirely unnecessary to do so, and secondly because it is sometimes difficult or impossible to do so on other than an arbitrary basis.

It may or may not be so that the majority of chemistry teachers disagreee with me in this. But either way the fact means nothing. One could draw any one of three conclusions, all of which would be equally reasonable on the basis of this fact alone: (1) that the majority of chemistry teachers would do well to change their views; (2) that I am an enthusiast with a bee in his bonnet; (3) that for any one of us the method which he honestly prefers is best.

You are quite right in objecting to the statement that $KMnO_4$ does not yield nascent oxygen in dilute sulfuric acid solution. In making that statement I was wrong on at least three counts. I fell into a tactical error in adding a second and superfluous reason to one which was quite sufficient in itself. I was guilty of inconsistency in advocating a method which eliminates the necessity of speculating on the mechanism of the reaction, only to comment on the probable nature of that mechanism in the next breath. And finally I committed the scientific crime of making a statement which is supported by insufficient and purely negative evidence.

One would ordinarily expect a decomposition involving the evolution of

[2] THIS JOURNAL, **4**, 1021–30 (Aug., 1927).

nascent oxygen to go on to completion due to the escape of the gas.[3] It is quite possible to assume, however, as others have done, that there is an equilibrium of such nature that the amount of oxgyen present does not exceed the solubility of the gas in the solution in question.

OTTO REINMUTH, *Associate Editor*

[3] It should be noted that the oxidizing effects produced preclude the possibility that the decomposition takes the course:

$$MnO_4^- \longrightarrow Mn^{++} + 4O$$

One may assume the improbable formation of Mn_2O_7, the anhydride of a strong acid, in dilute aqueous solution, with subsequent decomposition,

$$Mn_2O_7 \rightleftharpoons 2MnO + 5O$$

or one may postulate a self-oxidation-reduction on the part of the permanganate ion, such as:

$$2MnO_4^- + 2H^+ \rightleftharpoons 2MnO + H_2O + 5O$$
$$2MnO + 4H_2SO_4 \rightleftharpoons 2MnSO_4 + 4H_2O$$

It is also possible to write such an equilibrium as you have suggested,

$$MnO_4^- \rightleftharpoons Mn^{++} + 4O^{--},$$

if an equilibrium of that kind really seems plausible to you.

City Gas Chief Source of Carbon Monoxide Deaths. City illuminating or manufacturing gas is the chief source of deaths from carbon monoxide poisoning, the committee on poisonous gases of the American Medical Association has recently reported.

"The increasing use of city gas for heating homes may involve a large increase of fatalities both of individuals and of entire families unless an efficient inspection supervision and control of household gas appliances is established," the committee stated in its report. "City gas of high calorific value contains much less carbon monoxide than gas of low calorific value. It is in the interest of public health and safety that the amount of carbon monoxide in city gas should be reduced. To this end the price of gas should be based on the heat unit instead of the cubic foot. Scientific investigation for the development of less poisonous gas deserves liberal financial support."

The committee recommended that victims of carbon monoxide poisoning be treated with immediate artificial respiration by the prone pressure method. Pulmotors, lung motors, and similar mechanical devices should be discarded in favor of the prone pressure method. Inhalators, on the other hand, were recommended to be used to supply the victim with a mixture of oxygen and 5 to 7 per cent carbon dioxide, or with oxygen alone if the carbon dioxide is not available. Such a patient should be kept warm and prevented from making any physical exertion, even so little as sitting up, until he is fully restored to normal condition. Heart strain may result from allowing a partially resuscitated person to walk about or otherwise exert himself.—*Science Service*

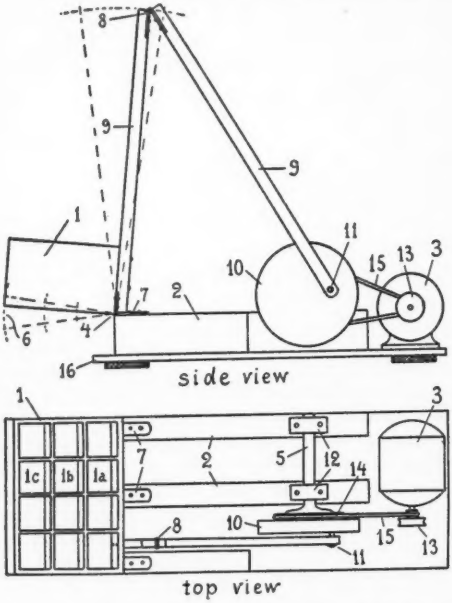
Find Three Vitamins in Malted Milk. Cheering news for those who make malted milk the mainstay of the working or school day is to be found in the report of E. J. Quinn and L. B. Brabec of Columbia University to the American Home Economics Association.

These investigators have found malted milk a good source of vitamins A, B, and G. However, a sample of a chocolate-flavored variety had not so high a vitamin content as the unflavored or "straight" malted milk. The extensive use of malted milk for invalid and infant feeding led the investigators to examine samples for vitamin content. Vitamin A is known as a preventive of eye disease, vitamin B prevents beri-beri, and vitamin G prevents pellagra.—*Science Service*

Chemical Digest

ABSTRACTS

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS



Shaking Machine for Analytical Work. A. L. ROMANOFF. *Science*, **71**, 320 (Mar. 21, 1930).—This machine consists of a box with compartments (1) hinged to a base (2) and brought into a swinging motion by an electric motor (3) through a mechanical "system of four-links chain," where (4) and (5) are the axes of oscillation and rotation, and (6) is the maximum amplitude of swinging. Other parts of the machine are indicated: the hinges (7) and (8), shear legs (10) with crank and pin (11), bearings (12), motor pulley (13), driving pulley (14), belt (15), and base plate (16).

The shaking can be done in the box (1) with several samples under various amplitudes of swinging. The first row of compartments (1*a*) provides mild, the second (1*b*) moderate, and the third (1*c*) intense shaking. If it is necessary, the amplitude of swinging in the machine can be easily adjusted by displacing the crank pin (11); and the speed of rotation can be regulated by the speed of the motor (3), using either a rheostat or several sizes of motor-driven pulleys (13). G. H. W.

How to Facilitate Filtration in the Laboratory. A. PARLOW. *Chem.-Ztg.*, **54**, 183 (Mar. 5, 1930).—The process of filtration cannot always be hastened by suction. Funnels usually have an angle slightly larger than the required angle of 60°. Hence the filter paper may tear when a heavy liquid is poured on it. It is therefore advisable to fold the paper to an angle of 93 to 98° as shown in Figure 1. Then the whole surface of the paper will touch the sides of the funnel.

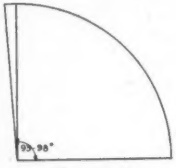


FIGURE 1

FIGURE 2

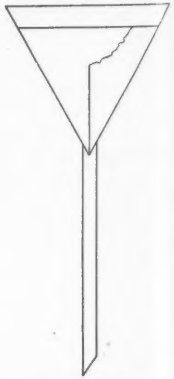


FIGURE 3

Often the liquid does not fill the stem of the funnel completely, even if stem is previously filled, but flows down in droplets. This is due to the fact that a small channel is formed where the paper is folded together. Air passes through this channel, breaks the liquid column in the stem of the funnel, and thus lowers the speed of the filtering process. The filtration proceeds irregularly. The entrance of air cannot be prevented by wetting the paper and pressing it tightly to the wall of the funnel. However, it can be remedied by the following simple trick: Tear off about 1 sq. cm. of the corner of the folded paper as shown in Figure 2. This breaks the channel afterward. It should be noted that the corner must be torn off and not cut off as the fine threads of paper prevent the entrance of air. Wet the paper as usual with water or the liquid to be filtered and press the paper to the wall of the funnel especially at the place where the corner has been torn off. (See Figure 3.) If this is done properly then the stem of the funnel will fill completely with the filtrate, the filtration will proceed regularly and quickly, and the filter paper cannot tear even when heavy liquids are used. L. S.

Dehydration of Analytical Precipitates by Heating. W. MIEHR, P. KOCH, AND J. KRATZERT. *Z. angew. Chem.*, **43**, 250–4 (Mar. 22, 1930).—Gravimetric methods can be divided into the following two divisions: 1. Methods in which the element or compound is precipitated from solution together with certain impurities which can be removed later on. 2. Method in which the element or compound isolated must be so pure and stable that it cannot undergo any change in weight by decomposition, adsorption of water, carbon dioxide, etc. The work taken up in this article deals with the second group, particularly with the dehydration of aluminum hydroxide, aluminum phosphate, and silicic acid. The authors discuss their experiments in detail and come to the following conclusions:

Aluminum hydroxide. (*a*) Aluminum oxide must be heated to constant weight at a temperature of at least 1200 °C., better yet 1300 °C. An ordinary gas-air blast lamp is not sufficient. (*b*) The weight of the heated oxide, when placed in the calcium chloride desiccator, should increase by only a few tenths of a per cent. (*c*) The heated oxide should be colored by alizarin only very faintly. If these conditions are not observed an error up to 4% may be caused by heating alone.

Aluminum phosphate. (*a*) Aluminum phosphate which has been heated by an ordinary blast lamp still contains 1% of water. This can be reduced to $^1/_2$% by the use of a better blast. (*b*) It should be heated to constant weight between 1200° and 1300° C. It should not be heated too long at 1300 °C. as phosphorus pentoxide may be given off.

Silicic acid can be ignited satisfactorily with an ordinary blast lamp. L. S.

A Simple Method of Removing the Last Traces of Water during the Evaporation of Solutions in the Laboratory. B. REWALD AND D. SCHWIEGER. *Chem.-Ztg.*, **54**, 281 (Apr. 9, 1930).—Foam is frequently formed during the evaporation of solutions especially when they are rich in protein. This formation of foam and of a skin makes the removal of the last traces of water rather difficult. The following little trick will help in many cases: Add a small quantity of benzene from time to time to the solution in a distilling flask while the solution is being boiled. In this way all the water can be removed rapidly without the formation of a skin or foam. The benzene can be recovered from the benzene-water distillate and can thus be used many times. L. S.

The Action of Chlorine on Ethylene. (Ethylene Chloride and the Preparation of Trichloroethane.) H. BAHR AND H. ZIELER. *Z. angew. Chem.*, **43**, 233–6 (Mar. 15, (1930).—Ethylene chloride is of commercial importance as it is the starting material for the manufacture of glycol. According to most textbooks, the preparation of ethylene chloride by the method summarized in the equation, $C_2H_4 + Cl_2 = C_2H_4Cl_2$, is one of the simplest reactions in the field of organic chemistry. This is not the case. It is necessary to adhere to very strict conditions if ethylene chloride is intended to be the main product of the above reaction. The patent literature advises that the temperature should be below 150 °C. and above 50 °C. The speed of the reaction is too slow below 50 °C. and large quantities of more highly chlorinated products are obtained above 150 °C. The use of catalysts is recommended in many cases. According to another method ethylene chloride is also obtained by passing ethylene through liquid chlorine.

The authors studied the synthesis of ethylene chloride and obtained the following results: (1) In the absence of catalysts ethylene chloride is formed from ethylene and chlorine only at low temperatures. Between −20 to −30 °C. the yield exceeds 90%. A further lowering of the temperature has little effect. The yield becomes poor with a rise of temperature. (2) At room temperature and above trichloroethane is

the main product. Ethylene chloride and more highly chlorinated products are formed at the same time. (3) The quantity of the various substances obtained in the reaction does not depend upon the relative quantities of ethylene and chlorine at all but is a function of the temperature alone. (4) The more highly chlorinated products are not formed by a secondary reaction of chlorine on ethylene chloride but they are produced directly from ethylene and chlorine. L. S.

Synthesis of Ethyl Mercaptan. S. GENELIN. *Z. physik. chem. Unterricht,* **43,** 80 (Mar.-Apr., 1930).—Ethyl mercaptan can be synthesized in the lecture room by means of the reaction given by the following simple equation: $C_2H_5Cl + KSH = C_2H_5SH + KCl$. Dissolve a small piece of potassium hydroxide in about 20 cc. of alcohol and saturate the solution with hydrogen sulfide in a small flask. The potassium hydrosulfide formed will stay in solution. Add a few cc. of ethyl chloride, stopper the flask, and let stand. At the end of the hour it is usually possible to notice the formation of mercaptan by its disagreeable odor and the precipitate of potassium chloride. Oily droplets of the ethyl mercaptan separate out on the addition of water. L. S.

Securing Photomicrographs of Snow Crystals. W. A. BENTLEY. *Educ. Focus,* **1,** 20–2 (Mar., 1930).—The apparatus necessary to photograph snow crystals consists of a microscope coupled to an extension camera, a black board about 15 inches square on which to catch flakes, a sharp-pointed wooden splint to pick up flakes, an observation microscope, several long glass slides, a feather duster, and several single wing feathers with which to press crystals flat on glass slides.

Snowflakes are placed on the glass slides and photographed by transmitted light with the sky or snow as background. The exposure varies from 8 to 60 seconds depending upon conditions. The photographing is done indoors in a room kept at or near the temperature of the outdoors. Haste is necessary as isolated snowflakes evaporate rapidly.

The snowflake photographer needs an unlimited amount of patience, and a love for the work; but the charm of novelty and of seeing designs ever new and chaste is always present and repays one for the effort. Of the countless flakes formed no two are ever alike. H. T. B.

Displaying and Filing Microscopic Preparations. A. T. RASMUSSER AND C. A. FISHER. *Science,* **71,** 289–90 (Mar. 14, 1930).—A sketch of that part of a microscopic preparation to be shown, with the necessary legends and explanations, is placed on a 5 × 8 inch cardboard having a drawing surface. This is covered with transparent celluloid and the two bound together with adhesive tape. On the back is fastened an envelope somewhat larger than the slide. Here is also recorded the necessary information regarding magnification to be used and key to the location of special cells or areas to be exhibited. "Ringing" the slide with India ink or a diamond point often simplifies matters. When filed away, the slide is kept in the envelope of the corresponding card. Card and slide should bear the same number.

These cards are neat, durable, and inexpensive. They make for simplicity in filing. G. H. W.

Revelations of the Spectroscope. J. W. FORREST. *Educ. Focus,* **1,** 6–8 (Mar., 1930).—There are three types of spectra: (1) the continuous band of color produced by incandescent solids, such as the carbon arc; (2) the discontinuous bright-line spectrum produced by incandescent gases; (3) the dark-line spectrum produced by light from an incandescent solid shining through a glowing gas which is at a temperature lower than that of the originating body. The glowing gas absorbs light of the same wave-length as it itself ordinarily emits, so that the spectrum of the solid body is crossed by a series of dark lines.

Spectroscopes consist essentially of: (1) the slit; (2) the lens system "composed of a collimating lens in the focal plane of which is placed a source, and the telescope or camera lens forming an image of this source in its focal plane." In visual instruments the lenses are corrected chromatically; in the photographic type the lenses are used to correct spherical aberration and coma; (3) the dispersing system which may be a prism or grating.

Certain factors of instrument design alter the efficiency. One is dispersion, which, in the case of the prism type, may be controlled by using prisms made of special type glass. The resolving power—the ability to separate a complex spectrum into a greater or smaller number of lines—is more difficult to handle. It is often difficult to find substances transparent to some wave-lengths. Quartz crystal is widely used for work in the ultra-violet region.

The astronomer, chemist, physicist, and many industrial engineers are finding the spectroscope a valuable tool. H. T. B.

The Formation and Growth of Crystals. See this title on page 1699.
Notes on Tests for Peroxides. See this title below.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

The Function of the Picture in Science Instruction. A. HORN. *Educ. Screen*, **9**, 75 (Mar., 1930).—The effort is made to examine the use of pictures in its relation to classroom experiment and demonstration. "Demonstrations are used in deriving scientific laws or generalizations. . . . Planning and executing such experiments is reputed to provide the pupil with training in scientific method." Some desirable experiments may not, for various reasons, be possible of performance. "A film showing the experiment is a more or less adequate substitute for the real thing." Thus used the film does not do violence to the aims or traditional methods of science teaching.

Modern science teaching recognizes increasingly the value of an organized study of environment. Environment already experienced is much prized by the science teacher but such environment's full worth is not attained unless it leads to the assimilation of further experience. At this point the picture becomes a vital part of the plan of science instruction.

A new plan of a science lesson might proceed according to: "(1) environmental experience, (2) experimental derivation of physical law, (3) application of these laws to previous and further environmental experience. In the first and third steps, the picture occupies a position of unique and fundamental importance, serving a purpose completely distinct from that of the experiment." B. C. H.

A Spiral Model of Rubber. H. FIKENTSCHER AND H. MARK. *Rubber Chem. Tech.*, **3**, 201–6 (Apr., 1930).—As the result of Harris, the synthesis of rubber-like substances and recent X-ray researches of Katz and Hauser, one is justified in regarding isoprene residue as the basis of the structure of rubber. The model suggested illustrates the best known physical and chemical properties of rubber as elasticity, work of stretching, heat tone during stretching, release, specific volume, X-ray interferences and double refraction, permanent elongation, swelling and salvation and vulcanization, which are discussed at some length. Illustration included. C. W. E.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

The Floundering Freshman. G. W. RIGHTMIRE. *J. Higher Educ.*, **1**, 185–92 (Mar., 1930).—By careful selection of the freshmen teachers, by having a "freshman week," and by aiding in the freshman's readjustment to university life a large state university is successfully meeting the problems presented by number and quality of the freshmen students. H. H. K.

Normal Amount of Teaching and Research. See this title on page 1704.

KEEPING UP WITH CHEMISTRY

Iodine—The "Element of Doubt." I. GRIFFITH. *Am. J. Pharm.*, **102**, 179–201 (Apr., 1930).—*One of a series of popular science talks given at the Philadelphia Coll. of Pharm. and Science.* The article relates the interesting details surrounding the discovery of the element and sets forth the properties and uses of iodine in a clever and interesting manner. The writer describes iodine as the ideal antiseptic and the surgeon's choice. Although iodine *per se* has little use in the industries, its compounds find practical application in many fields until the author admits we are afflicted with an "iodophobia." It is true that we are the "trivial toys of a mite of iodine," but we must not overlook the fact that harm can come from feeding iodine to individuals who already have enough. Physiologists tell us that the thyroid gland in some mysterious way keeps the iodine content of our blood, which is very small, constant and accelerates every body function. The quacks soon saw the trick of thyroid and capitalized it for "girth control," for with its administration to a normal person under lessened diet, the body fires naturally burn more brightly and flesh is "boiled away." Surely it will cause a reduction of weight, but it will also reduce one's lease on life. Thyroid should never be administered except under competent medical supervision. Mention is also made of South Carolina and the alleged heavy iodine content of her vegetables. G. O.

Notes on Tests for Peroxides. C. J. PINES. *Am. J. Pharm.*, **102**, 221–2 (Apr., 1930).—In the course of investigations as to the quality of commercial ether [Leffmann and Pines. *Am. J. Pharm.*, **102**, 58 (1930); see THIS JOURNAL, **7**, 1416 (June, 1930)] comparisons were made among three of the generally used tests for peroxides. These are additional notes on these tests. The three commonly employed are chromic acid,

vanadic oxide dissolved in sulfuric acid, and a mixture of equal parts of cadmium and potassium iodides. The last named is prescribed by the current U. S. Pharmacopeia. The first is eminently suited for detecting peroxides in ether because it can be prepared easily in the laboratory while the vanadic oxide test, although prompt and fairly delicate, is expensive. The third test is directed by U. S. P. X and uses equal parts of the iodides in a 10% solution. The solution if kept for a considerable time must be kept in the dark. It is directed that the reagent be mixed with the sample and occasionally agitated in the dark. The test depends upon the liberation of iodine by the peroxide. The addition of starch will increase the delicacy of the reaction and avoid the tedious process of the Pharmacopeia. Starch paper may be used but the starch solution is much more satisfactory, the starch solution being preserved by the addition of oil of cinnamon. A solution of 0.5 g. mercuric iodide and 2.5 g. potassium iodide in 50 cc. water with starch solution gave satisfactory results. One drop of U. S. P. X hydrogen peroxide in 100 cc. distilled water was made and about 10 cc. tested with the mercuric solution. A marked purplish blue tint developed in five minutes. G. O.

Moisture Content of Carbon Blacks. W. B. PLUMMER. *Rubber Chem. Tech.*, **3**, 185–9 (Apr., 1930).—Use of Carson's method [*Ind. Eng. Chem., Anal. Ed.*, **1**, 225 (1929)] for moisture in carbon blacks gave some interesting results. C. W. E.

Commercial Uses and Production of Beryllium. ANON. *Chem. Age, Mo. Met. Sect.*, **22**, 15–6 (Mar. 1, 1930).—Beryllium has about the same density as magnesium, melts at 1285°C., and is almost as hard as quartz. The present market price is about $200 per pound, but indications are that when demand becomes large enough to warrant commercial production of the metal the price will be greatly lowered. It probably will become important in the preparation of alloys with aluminum and with iron to each of which it imparts valuable properties, and in the manufacture of refractory glass. E. R. W.

Monel Metal: Production, Properties, and Applications. N. C. MARPLES. *Chem. Age*, **22**, 263–4 (Mar. 22, 1930).—Monel metal, named after President Monel of the International Nickel Co., was first prepared more or less by chance. Certain ores containing both nickel and copper were available, the separation of the metals from each other was difficult so it was decided to smelt out the two metals together. The result was an alloy containing about $^2/_3$ nickel and $^1/_3$ copper with small amounts of iron and manganese. In many respects this alloy is superior to pure nickel or pure copper and the present consumption exceeds 1400 tons per month. The paper includes an outline of the properties and uses of the metal which are responsible for the popularity of this alloy. E. R. W.

Causes of Spontaneous Heating of Coal. ANON. *Chem. Age*, **22**, 218–9 (Mar. 8, 1930).—A review of the factors, both chemical and physical, which influence the spontaneous combustion of coal. The heat is liberated principally from oxidation of carbon and gaseous hydrocarbons on the surface of the coal. The rate at which this heat is evolved varies with the type of coal, the size of the pieces, moisture content, available air, temperature of the coal, etc. A bibliography of six references is included. E. R. W.

The Structure of Silicates. W. L. BRAGG. *Nature* (London), **125**, 510–1 (Mar. 29, 1930).—A lecture delivered before the Mineralogical Society on March 18th. A description of the silicates considered in the light of the new knowledge of this atomic arrangement as determined by X-ray analysis. F. B. D.

Silicates and Food Production. ANON. *Silicate P's & Q's*, **10** (Apr., 1930).—The addition of a small per cent of sodium silicate to the pyrethrum-soap spray, which has been used against the Japanese beetle, renders it more toxic, probably through its ability to wet oily surfaces and as an emulsion stabilizer.

Silicate appears able to release phosphate from the soil, and thus make it available for plants. This property of silicate may be of value if prices of phosphate fertilizers rise markedly.

Silicate gels are of use in the propagation of certain specific spawns in that they enable biologists to determine the organic matter on which the spawns thrive best. H. T. B.

Silica Gel, a Valuable, New Adsorbent. A. SALMONY. *Chem.-Ztg.*, **54**, 277–9 (Apr. 29, 1930).—Activated charcoal was considered to be the best adsorbent during the World War but during the last few years a rival has risen in the form of colloidal silicic acid, so-called silica gel.

A great advantage of silica gel is its incombustibility. It can be ignited to high temperatures with oxidizing flames. This is not true in the case of activated charcoal. Silica gel also excels the coal by its high mechanical strength. It can easily be re-

generated. Several methods of making silica gel in the laboratory are described. The Silica Gel Corporation of Baltimore succeeded in manufacturing this material on a commercial scale. It is produced in a dust-free granulated form of nearly white color. One gram has a surface of about 450 square meters, which explains its high adsorptive power.

Silica gel found many commercial applications in America. The Iron and Steel Co., Glasgow, has been using it since 1927 to dry the air for blast furnaces. A. Borsig, G. m. b. H., Berlin, coöperated with the Silica Gel Corporation, Baltimore, and introduced the new adsorbent to the chemical industry in Germany. The silica gel business in Germany was taken over about a year ago by Silica Gel, G. m. b. H., Berlin. It is now manufactured in several plants in Germany where it has found many uses.

L. S.

Natural Coagulation of Hevea Latex. A. S. CORBET. *Rubber Chem. Tech.*, **3**, 254–63 (Apr., 1930).—Presentation and discussion of theories of enzyme action, bacteria action, work of de Vries and Beumee-Nieuwland are reviewed. Corbet's investigations involve bacteriological study of Hevea latex and show that one organism predominates, for which the name *B. pandora* is proposed. *B. pandora* is able to decompose latex with production of acid and hence bring about the separation of rubber particles. At a late stage it attacks the proteins with production of ammonia.

C. W. E.

The Question of Vulcanization without Sulfur. F. KIRCHOF. *Rubber Chem. & Tech.*, **3**, 190–4 (Apr., 1930).—Experiments on hot vulcanization and vulcanization in ultra-violet light with the aid of 1-3-5-tri-nitro-benzene and picric acid. C. W. E.

The Non-Volatile Constituents of Mentha Piperita. H. C. BRAUN. *Am. J. Pharm.*, **102**, 202–19 (Apr., 1930).—An experiment which it is hoped will increase the material now known about the "Biochemistry of Mints" [*J. Biol. Chem.*, **50**, 31 (1922)]. Peppermint has been cultivated since the middle of the 18th century almost exclusively for its volatile oil. Twenty-nine different volatile constituents of this plant are known but next to nothing is known of its non-volatile constituents. Thirty-six pounds of peppermint leaves harvested in the Pharm. Garden during the summer of 1926 were subjected to examination as to moisture and ash determination and quantitative extraction of leaves with selective solvents. The results are listed and compared with Gordon's results of *Mentha Aquatica*. G. O.

Structure of Fats and Its Bearing on Their Utilization. T. P. HILDITCH. *Chem. Age*, **22**, 238–9 (Mar. 15, 1930).—A review of the use of plant and animal fats and oils in the manufacture of soap, paints and varnishes, and edible products. Between 100 and 200 natural fats are of present industrial importance out of about 1400 different types that have been investigated. A rough classification of fats according to structure and use is included. E. R. W.

Activated-Sludge System Installed in Grand Canyon National Park. M. R. TILLOTSON. *Compressed Air Mag.*, **35**, 3093–7 (Apr., 1930).—Every drop of water used in this park for some 162,000 visitors and 400 inhabitants, for two hotels, a branch railway, a laundry, and an ice plant and for other uses must be hauled in tank cars a distance of 122 miles at a cost of $3.09 per 1000 gallons. Because of this expense it has been found advisable to provide a sewerage system of such a type that the effluent might be re-used in boilers, irrigation, and for other non-domestic purposes. The plant, which is in operation, operates as follows. Raw sewerage is agitated with from 15 to 25 per cent of its volume of biologically active liquid sludge in the presence of air until a large proportion of the colloidal material has been coagulated. This treatment is followed by a period of sedimentation, the sediment is used as active sludge and the supernatant liquid is drawn off as effluent, sterilized with chlorine, and used for the non-domestic purposes mentioned above. The article is well illustrated. E. R. W.

Revelations of the Spectroscope. See this title on page 1696.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

The Formation and Growth of Crystals. ANON. *Chem. Age*, **22**, 242–3 (Mar. 15, 1930).—A review of a paper delivered by W. E. Gibbs and of the discussion which followed its presentation. The effect of agitation of the evaporating solution and of the degree of supersaturation attained before crystallization starts, on the size of crystals obtained, is briefly discussed. E. R. W.

A Survey of Recent Literature on the Chemistry of Rubber. ANON. *Rubber Chem. Tech.*, **3**, xli–lxii (Apr., 1930).—Abstracts of 237 articles pertaining to the chemistry of rubber which have appeared in recent foreign and American journals. C. W. E.

HISTORICAL AND BIOGRAPHICAL

Victor Grignard. (1) *Les Prix Nobel en 1912.* P. A. Norstedt & Soner, Stockholm, Sweden, **1913,** pp. 18–24, 56–9. Contains a brief outline of work for which Nobel award was made, brief biographical notes, summary of researches, and portrait. (2) *Chem.-Ztg.,* **36,** 1449–51(1912). An account of the Nobel prize winners for 1912. The account of Grignard is written by F. Schmidlin. (3) *Caoutchouc & gutta-percha,* **23,** 13,190 (1926). A biographical note and portrait of Grignard in the laboratory. (4) *Independent,* **73,** 1438–9 (Dec. 16, 1912). An account of the Nobel prize men of 1912, which includes comment on Grignard. M. W. G.

Paul Sabatier. (1) *Les Prix Nobel en 1912.* P. A. Norstedt & Soner, Stockholm, Sweden, **1913,** pp. 24, 55–6. Contains a brief outline of work for which Nobel award was made, brief biographical notes, summary or researches, and portrait. (2) *Chem.-Ztg.,* **36,** 1451–2 (1912). Brief account of work of Sabatier up to time of Nobel award in 1912. M. W. G.

The Scientific Work of Irving Langmuir. K. T. COMPTON. *Chem. Bull.,* **17,** 119–21 (Apr., 1930).—Few scientists since Helmholtz have made fundamental contributions in so many fields as has Langmuir. His work on "space charge" and "monatomic films" is outstanding in its importance. The former led to the invention of the vacuum tube; the latter to thoriated filaments and some conception of the shape of organic molecules. The author has mentioned in some detail other work that Langmuir has done.

The method of attack used by Langmuir is interesting and characteristic. First he makes a careful series of quantitative measurements, then analyzes the data and formulates a theory, finally he reduces the theory to mathematical form and tests it rigorously with the data. H. T. B.

Liebig. See abstract on **Science and Life,** page 1703.

Nobel Prize Awards. ANON. *Nature* (London), **125,** 532–5 (Apr. 5, 1930).—This gives a complete list of the recipients since 1901. The data of the distribution of Nobel Prizes for physics, chemistry, physiology, and medicine, are classified according to countries, each country representing the working domicile of the recipient at the time of allotment of the prize.

	Physics	Chemistry	Physiology & Medicine	Total
Austria		1	2	3
Belgium			1	1
Canada			1	1
Denmark	1		3	4
France	6	4	3	13
Great Britain	6	5	3	14
Germany	8	12	5	25
Italy	1		1	2
Netherlands	3		2	5
Russia			1	1
Sweden	2	3	1	6
Spain			1	1
Switzerland		1	1	2
Tunisia			1	1
United States	3	1	1	5

F. B. D.

Robert Franz Pschorr. O. GERNGROSS. *Chem.-Ztg.,* **54,** 181 (Mar. 5, 1930).—Prof. Dr. Robert Pschorr, *ordinarius* for organic chemistry at the Technische Hochschule, Charlottenburg, died in Munich on Sunday, February 23, 1930, at the age of 62.

He was born in Munich on February 4, 1868 (this date differs from that given in abstract below). After attending the high school there he studied chemistry with Adolph v. Baeyer. Later he studied under Eugen Bamberger in Zurich and completed his studies with Ludwig Knorr in Jena. His doctor's thesis dealt with 1-phenyl-2, 3-dimethyl-4-oxy-5-pyrazolon, an oxyderivative of antipyrine. He then was attracted by Emil Fischer to the first Chemical Institute of the University of Berlin. In 1896 he published a report on a new synthesis of phenanthrene and its derivatives. This famous and general synthesis named after him was decisive for the main part of his life work, which was devoted to the constitution of opium, morphin, thebain, codein, and apomorphin.

When Liebermann died in 1914 Pschorr was advanced from divisional director of

the Chemical Institute to the *ordinarius* of organic chemistry at the Technische Hochschule in Charlottenburg.

He occupied many positions. At various times he served as Rektor, Dekan, and Senator of the University. He was first chairman of the Student's House in Charlottenburg, editor of the *Berichte der Deutschen Chemischen Gesellschaft*, chairman of the Verein Deutscher Chemiker, and chairman of the Pschorr-Brau, A. G., in Munich.

He was loved by his students and colleagues and left only friends. L. S.

Robert Pschorr. P. DUDEN. *Z. angew. Chem.*, **12**, 245–6 (Mar. 22, 1930).—Robert Pschorr died on February 23, 1930. He was born in Munich on December 4, 1868 (this date differs from that given in abstract above). He studied in Munich and Zurich and he worked with Ludwig Knorr in Jena. Pschorr started his research work on the pyrazol series and morphin alkaloids. He prepared 4-ketopyrazolon and antipyrin-alcohol. In 1896 he made a trip around the world with his friend Herbert von Meisler. When he returned he continued his work with Emil Fischer in Berlin where he worked on derivatives of phenanthrene. Taking the advice of Emil Fischer he became associated with the University of Berlin in 1899. In the same year he married Miss Tilla Scherer. He continued his work on apomorphin and thebain. In the fall of 1913 he took over Karl Liebermann's teaching position of organic chemistry at the Polytechnic Institute in Charlottenburg. During the four years of the World War he served as a major in the army. In 1920 he was elected Rektor of the Institute.

Pschorr was a very friendly and active personality. His memory will not be forgotten by his friends and colleagues. L. S.

The Nobel Prizes for Research Work in Science. *Nature* (London), **125**, 495–7 (Mar. 29, 1930).—A sketch of Nobel's life, the design of his will, and the Nobel committee. F. B. D.

Longstaff Medal and Harrison Memorial Plaque. See this title on page 1705.

Franklin Medal. See title **The Franklin Institute,** this issue, page 1757.

Levy Medal. See title **The Franklin Institute,** this issue, page 1757.

Willard Gibbs Medal. See title **The University of Chicago,** this issue, page 1719.

Theodore William Richards Medal Fund. See this title, this issue, page 1709.

EDUCATIONAL MEASUREMENTS AND DATA

Coördination of Preparatory and Engineering Education. T. M. FOCKE. *J. Eng. Educ.*, **20**, 473–84 (Jan., 1930).—The author is the chairman of a committee appointed "to study predictive indices of probable success on the part of students in engineering courses." The paper represents a contribution to the study.

Instead of trying to measure the predictive value of any set of data by getting its coefficient of correlation with the students' college grades, a relationship has been sought between those data and college survival. The contention is made that a student's success in college is more truly indicated by learning whether or not he has kept pace with his group and completed his work in the expected time. So in the studies presented each class is ranked into five groups upon the basis of the data under study and the history of each of the five levels is charted for per cent of survival, per cent leaving the group because of scholarship, and the per cent who left for other reasons.

Data so studied included: high-school mathematics grades, high-school physics grades, high-school rank Army Alpha test, Thurston test, Council on Education test, high-school algebra tests, S. P. E. E. algebra test, Iowa mathematics training test, and mathematics aptitude test.

Findings of the study are: (1) General intelligence tests have very little predictive value for "survival" of engineering students. (2) Averages of high-school mathematics grades give very good predictions that low men will not survive. (3) Students in the lowest third of high-school classes are very poor risks. (4) High-school physics grades give a fair prediction of survival but are not as certain in predicting failure at the lower end of the scale as are mathematics grades. (5) An average of high-school physics and mathematics is no more predictive than mathematics alone. (6) Tests on algebra proved more certain in predictive value than any single subject. The Iowa mathematics training test was also very satisfactory for such purposes. (7) An average of all Iowa placement tests gave a very definite idea of the chances of survival of the different fractions of the class. B. C. H.

The Articulation of High-School and College Subject Matter. See this title on page 1702.

Sixty Educational Books of 1929. *J. Natl. Educ. Assoc.*, **19**, 129–32 (Apr., 1930).—Reviews. A. E. C.

THE PHILOSOPHY OF EDUCATION

The Intellectual Life in the Colleges. L. P. EISENHART. *Assoc. Am. Coll. Bull.*, **16**, 42–52 (Mar., 1930).—The Dean of the Faculty of Princeton U. propounds several thought-provoking questions among which are: Have we given our students a real part in their own education? Have we expected enough of our students? What can you say to a student which will convince him that it is not enough merely to pass his courses, accumulate credits, and get a diploma? Each college must solve its own problem; but "when the youths appreciate the fact that the U. S. has emerged as a result of the war into an outstanding position in the world; that their generation and those to follow will be called upon to solve problems in finance, politics, and commerce of more extensive dimensions than their fathers faced; that the situations demand knowledge not only of their own, but also of foreign civilizations, acquired by the study of literature, philosophy, geography, history, and art, and knowledge of politics, economics, and sciences; and that, in so doing, they will be developing their powers against the future; then they will have only to be convinced that the colleges can meet the need." Therein lies the responsibility of the colleges, rather than in seeing to it that the students do their lessons.

H. SUZZALLO. *Ibid.*, 53–62.—In addressing the Assoc. of Am. Colleges, Mr. Suzzallo maintains that the prime necessity is to bring about a more vital relationship between the student and the teacher; that we are not going to develop the intellectual life of American students until we abandon the whole scheme of measuring college achievement by time, by the number of minutes in the professor's hour. How much the student worked in that hour nobody knows. The best substitute, he believes, is the comprehensive examination. He advocates the introduction of the honors system of independent study in the last two years of college and a two-way-course scheme. The latter is a scheme by which a student registers for four subjects, but he may register in one or more courses in one of two ways: he may take the course in class or he may take it in independent study. Thus at least the best students are cared for and the timid student grows in self-confidence. G. O.

Achievements of American Education. *J. Natl. Educ. Assoc.*, **19**, 105–8 (Apr., 1930).—*In instruction:* teaching is broader, more specific than formerly and is now guided by definite scientifically established principles. Rationalization is aimed at in all subjects taught. *In organization:* special schools exist which meet the needs of school children. There is need of unity of control, in order to focus departments, bureaus, and agencies upon the teaching process. *In administration:* an evolution from uncertain leadership to rather highly professionalized directorship has taken place. *In the school plant:* new school buildings with adequate sites are replacing the old. *In personnel:* there is more scientific selection of teachers today than formerly. Greater care is being taken in the proper placing of teachers. Increased opportunities for growth in service have been provided. Salaries have been increased. Approval of the public and widespread appreciation of the teacher have improved the teacher personnel. *In finance:* increased cost of public education has resulted from increase in school attendance, and school house construction. Attendance has increased especially in the high schools. There have been no investigations to show how much education does to create the values in the property which pay the taxes. A. E. C.

Education in the Spirit of Life. F. CODY. *J. Natl. Educ. Assoc.*, **19**, 103 (Apr., 1930).—If the outlooks of the teacher are progressive, practical, dynamic, recreative, friendly, coöperative, and idealistic, then the schools will be likewise. A. E. C.

The Articulation of High-School and College Subject Matter. G. D. STODDARD. *Sch. Exec. Mag.*, **49**, 355 (Apr., 1930).—The schooling of a person should present a continual and unbroken unfolding of experiences and facts revelatory to life. The break between high school and college necessarily complicates matters and presents obstacles. Among the complications and obstacles discussed in this article are the coddling of high-school seniors; college teaching methods differing from high-school methods; the epidemic of junior colleges; the deadly parallelism of textbooks; and the overlapping of high-school and college courses.

Studies are quoted in which it has been shown that there is 48% repetition in college chemistry texts of material presented in high-school texts and 54% repetition in laboratory guides. Books published by the same authors in both the high-school and the college field show chapter headings are the same, the same line drawings appear, the same etchings, the same industries are illustrated.

The idea that freshman instructors prefer to teach chemistry to students who have never dabbled in the subject in high school is not warranted on the basis of the grades these students make in the course.

If students who have had high-school chemistry are segregated in instruction their course should be based on an examination, and hence be a real advance and not an amplified echo of their previous course.

The attainment of the poorer half of both high-school and college freshman chemistry classes is not due entirely to the incompetency or inefficiency of the teachers, but the mental limitations of these students is a factor. J. W. H.

Claremont Colleges. Some Educational Purposes and Results. J. A. BLAISDELL. *Assoc. Am. Coll. Bull.*, **16**, 63–75 (Mar., 1930).—An experiment which contemplates the development of small residential colleges, wholly independent in entity and administration, but "voluntarily coöperative" in such a way as to make for economy and "variety and mutual inspiration." There now exist at Claremont three separate educational organizations: Pomona College, the mother institution; Scripps College, an undergraduate institution organized primarily for women; and Claremont College, which functions to the common interest of all concerned. The latter oversees such graduate work as now exists, the summer school, the health service, the construction of buildings for common use, employs a limited faculty of its own, and concerns itself with the development of the whole plan. The idea back of it all is the belief that the small college is the most effective educational unit because of its limited student body. The plan, as they have conceived it, has resulted, they claim, in conserving the small college and high scholastic ideals; in creating the center of educational life in the student residence; in bringing to the institutions a higher grade of teaching personnel; and finally, in giving to each an absolute freedom to experiment in the presence of uninvolved observers. G. O.

The Use of Leisure. H. SUZZALLO. *J. Natl. Educ. Assoc.*, **19**, 123–6 (Apr., 1930).—At the present time the average man and woman has more leisure than ever before. The problem is how to use this time to the greatest advantage. Suzzallo sets forth six guiding principles. First, let us give leisure, recreation, or free time for the individual as respectable a place in our scheme of life valuations as we give to work. Second, let the time conventions of life be arranged to protect the privacy of free time. Third, let us not permit supplementary and coördinate aspects of wholesome human living to become rivals or competitors, each seeking to crowd the other out. Fourth, let us provide opportunity to train for a good use of leisure everywhere we can in life. Fifth, let play opportunities be of every good kind. Sixth, in whatever program we set up, let us educators profit by our rather long and somewhat sad experience in the intellectual field. A. E. C.

Sixty Educational Books of 1929. See this title on page 1701.

THE PHILOSOPHY OF SCIENCE

Science and Life. G. LUSK. *Science*, **71**, 271–5 (Mar. 14, 1930).—An interesting discussion of the life of Dr. Justus Freiherr von Liebig and his contributions to science is given. G. H. W.

The Relationship between Science and Engineering. G. DUNN. *Science*, **71**, 276–7 (Mar. 14, 1930).—The science of biology has its art of medicine. The science of anatomy has its art of surgery. The science of astronomy has its art of navigation. The sciences of mathematics, mechanics, physics, and chemistry have their art of engineering, which is the art of the economic application of these sciences to the purposes of man. G. H. W.

The Methods of Research. I. Back to Aristotle. W. D. BANCROFT. *Rice Inst. Pamphlet*, **15**, 167–223 (Oct., 1928).—In his first paper of a group of three, Bancroft contrasts inductive and deductive reasoning. He considers Bacon the exponent of the first and Aristotle of the second. But to avoid confusion, he coins two new terms and calls those who accumulate facts, accumulators, and those who start early with working hypotheses, guessers. He classifies under these headings many prominent scientists of the past and present, especially chemists and physicists. He considers there is a place in the world for accumulators, but strongly favors guessers. He objects strongly to a student who might have become a guesser being forced to become an accumulator, because he is unaware of the first type of research. **II. The Misleading Experiment.** *Ibid.*, 224–85.—Bancroft in his second lecture defends the thesis that an experiment should never be trusted until it has been checked by a good theory. He cites many misleading experiments in the fields of chemistry and allied sciences. **III. How to Think.** *Ibid.*, 286–352.—In his third lecture Bancroft states that there are two kinds of thinking, the conscious and the unconscious. He states that chemists spend a great deal of time in teaching students manipulation of apparatus but little in teaching them how to think. It is difficult to teach graduate students to ask why

and how to think. The either-or method or the Socratic method has several advantages. It eliminates a great many possibilities definitely, there is no error due to changing two variables simultaneously, and one knows exactly where one has failed if that has happened. The sources of errors are inadequate exclusiveness, experimental error, inability to devise an experiment to enable one to distinguish between the mutually exclusive alternatives, inability to formulate an either-or. He considers the Socratic method the proper method to do conscious, scientific thinking. It seems to be generally recognized that scientific ideas seem often to be an inspiration. But an inspiration develops out of unconscious reasoning. By means of the supra-marginal consciousness, many problems are solved. Bancroft discusses several views of conscious and unconscious thinking. A. E. C.

PROFESSIONAL

Great Teachers. R. L. KELLY. *Bull. Am. Assoc. Univ. Profs.*, **16**, 252–6 (Mar., 1930).—One hundred eighty-seven colleges contributed through their administrative officers, to a study of the attributes, training, and teaching habits of "great teachers."

Some of those reporting intimated that great teachers were often figments of the administrative publicity and that they were very likely to be increasingly great in the minds of their students in a direct ratio to the number of years which have elapsed since the student rating the teacher has sat in that teacher's classes.

The decade 1911–20 contained more great teachers than any other even as far back as 1841; many more are reported for the twentieth century than for the nineteenth and in general great teachers are well distributed through the history of the college.

Of the 162 great teachers 142 had doctor's degrees. English claimed 68 of them; mathematics, 57; philosophy, 44; Greek, 42; Latin, 40; history, 36; biology, 30; chemistry 29; Bible, 24; science, 20; education, 17; social science, 13; German, 12; and psychology, 12.

Forty per cent of the reports considered research an important feature of successful teaching. Eighty-five per cent of those who engaged in research were noted for their fruitful student contacts. Not all great teachers had done graduate work, however.

In general it would seem that the great teacher is more than a classroom man; he is not always trained in education though administrators are increasingly asking for such training in their candidates; he has not been easy with his students but rather has inspired them to greater individual effort; he has stimulated his students to frequent the libraries, and is noted for the number from his classes who go on for graduate work. "The personal traits of the great teachers are in order—interest in students, mastery of subject, sympathy, helpfulness, character and personality." B. C. H.

Normal Amount of Teaching and Research. COMMITTEE T, AM. ASSOC. UNIV. PROFS. *Bull. Am. Assoc. Univ. Profs.*, **16**, 206–14 (Mar., 1930).—The committee reporting does not feel that the administrator's assumption that the problem is largely one of the mechanics of schedule making, *i. e.*, of so many classes per professor meeting so many times per week, is adequate or fair. Many professors have been selected "not merely for their knowledge and their skill in imparting it; but perhaps even predominantly for quite other reasons. These other duties appear neither upon the teacher's schedule nor in the contract." In other words it would appear "that the professor as a class is expected to engage in numerous outside activities." These "outside activities" are not recognized by the administrator's method of determining the "load" of his professors.

The question is raised, "Is research an outside activity?" To the surprise of many it is said to be frequently so classed. "In some departments, the directing of graduate theses does not count upon hours of the professor's schedule." Some institutions by their very failure to give research recognition upon the institution's time might, with no violence to logic, be assumed to say, "Research is the professor's own business, in no way connected with his effectiveness as a teacher."

Even some regularly scheduled teaching activity, such as laboratory work, "seems to be (penalized) almost universally on a two for one basis." Even assuming that hours so spent are less important than those spent on class work, the time required of which "he has only a certain amount" is not replaced. This fact needs recognition at the hands of the administrator.

In view of these omissions from existing plans for scaling the professor's load the committee suggests that: (1) all phases of his work be cataloged; (2) an adequate measure of the teaching load be defined; (3) this scale be tried out upon some selected type institutions; (4) provision be made for propagating these findings among

the institutions which could be benefited by them; (5) other interested agencies be invited to coöperate in this project. B. C. H.

The Doctor of Philosophy and College Teaching. G. J. LAING. *Assoc. Am. Coll. Bull.*, **16,** 95–113 (Mar., 1930).—An interesting address because of its bearing upon a recently issued circular of the Association in which a relaxation of the research requirement in the case of candidates for the doctor's degree who intend to teach in colleges was recommended. [*Assoc. Am. Coll. Bull.*, **15,** (Nov., 1929).] G. O.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Degree of Chemical Engineer at Cornell University. ANON. *Science,* **71,** 278–9 (Mar. 14, 1930).—A notice of the degree, its purpose, and its requirements. [See THIS JOURNAL, **7,** 1127–30 (May, 1930).] G. H. W.

Industrial Fellowships of Mellon Institute during 1929–30. *Ind. Eng. Chem., News Ed.*, **8,** 1 (Apr. 10, 1930).—This article includes notes on the present status of the Institute's activities, researches in progress, various contributions to the literature, and a list of the industrial fellowships in operation at the Institute during the fiscal year ended February 28, 1930. M. W. G.

Longstaff Medal and Harrison Memorial Plaque. ANON. *Nature* (London), **125,** 538 (Apr. 5, 1930).—At the annual general meeting of the Chemical Society (London) on March 27th, the Longstaff Medal was awarded to Dr. W. H. Mills and Harrison Memorial Plaque and Prize to Dr. R. P. Linstead. Each was given for notable contributions in the field of organic chemistry. F. B. D.

Franklin Medal. See title **The Franklin Institute,** this issue, page 1757.

Levy Medal. See title **The Franklin Institute,** this issue, page 1757.

Willard Gibbs Medal. See title **The University of Chicago,** this issue, page 1719.

Theodore William Richards Medal Fund. See this title, this issue, page 1709.

Guggenheim Fellowship Awards for 1930. See title **John Simon Guggenheim Memorial Foundation,** this issue, page 1709.

Sixteenth Annual Meeting of the Association of American Colleges. *Assoc. Am. Coll. Bull.*, **16** (Mar., 1930).—This issue contains the complete proceedings of the sixteenth annual meeting of the Association of American Colleges. The Table of Contents includes:

1. *Editorial:* Intellectual Life in Our Colleges, ROBERT L. KELLY.
2. In Honor of the British Ambassador and Lady Isabella Howard.
3. World Peace and the College—The Presidential Address, GUY E. SNAVELY.
4. The Place of the Fine Arts in Education, CHARLES MOORE.
5. The Annual Report of the Executive Committee and the Executive Secretary, ROBERT L. KELLY.
6. The Intellectual Life in the Colleges, LUTHER P. EISENHART and HENRY SUZZALLO.
7. Claremont Colleges: Some Educational Purposes and Results, JAMES A. BLAISDELL.
8. Educating College Teachers, A. H. UPHAM.
9. The Improvement of College Teaching, WILBUR L. CROSS.
10. The Doctor of Philosophy and College Teaching, GORDON J. LAING.
11. Recent Developments in the Catholic College, GEORGE JOHNSON.
12. The Annual Review of College Surveys, FRANK L. MCVEY.
13. College Chapel Buildings in America, CHARLES C. MIEROW.
14. Report of the Commission on College Athletics, BERT E. YOUNG.
15. The Appointment Service of the American Association of University Professors, JOSEPH MAYER.

Abstracts of papers (6), (7), and (10) appear in THIS JOURNAL, pages 1702, 1703, and 1705, respectively. G. O.

GENERAL

Encouragement of University Research. COMMITTEE R, AM. ASSOC. UNIV. PROFS. *Bull. Am. Assoc. Univ. Profs.*, **16,** 201–6 (Mar., 1930).—An article given largely to a consideration of research in the social sciences and the humanities. B. C. H.

The Age of Meteorites. F. PANETH, WM. D. URRY, AND W. KOEGK. *Nature* (London), **125,** 490–1 (Mar. 29, 1930).—The authors have determined the helium and radium ratio in 27 iron meteorites and from these data have calculated that the ages of the meteorites range from 16 to 2900 million years. None of them are older than the age

of the earth. "The solidification data of all meteorites so far studied accords well, therefore, with the assumption that iron meteorites originate not from distant celestial bodies, but from our solar system." F. B. D.

Some Aspects of Human Biology. G. H. PARKER. *Sigma Xi Quart.*, **18**, 18–28 (1930).—"In my opinion there are two springs to human action. The first . . . has its source in . . . social inheritance; the second arises (from) our organic inheritance."

Social inheritance depends upon learning and teaching. "Learning is an animal process reaching down to very primitive creatures." Teaching is restricted to only the highest members of the animal kingdom.

Organic inheritance is transmitted through germinal elements, the egg and the sperm. These tremendously small entities are freighted with great responsibility so far as the future of the human is concerned.

To improve the human race requires that these two factors be clearly differentiated in our thinking. Each will probably have to be modified to produce the desired result. The principal efforts toward such modification have thus far been upon the social phase of inheritance.

Control of germinal inheritance is only in its inception. Some difficulty has been experienced in making sure just how much of the elements of man's inheritance are germinal and how much are social. The study of identical twins has helped somewhat in this problem but it is generally conceded that only a beginning has been made. A public attempt to control germinal heredity is found in the segregation of the defective members of the race and in some states the sterilization of such individuals. "(This) marks the first step in government control of organic human inheritance, the importance of which we are just learning to recognize." B. C. H.

Radium Commission of London Receives "Bomb." The Radium Commission, London, announces, according to the *Journal of the American Medical Association*, that the 4-g. "bomb" has been received from Belgium and, after being measured and tested in the National Physical Laboratory, it was handed over to the Westminister Hospital, where arrangements for its installation and manipulation and the treatment of patients had already been made. If at the end of three months the National Radium Trust decides to purchase the radium composing the bomb, it will be entrusted to the hospital for a further period of three years at a rental of $2000 a year, and the hospital will maintain a continuous day and night service with the bomb, in the pursuit of objectives prescribed by the commission. The commission has decided to recognize as national radium centers only such places as possess medical schools with complete clinical courses and facilities for giving instruction in radium therapy. The commission believes that the need for trained workers is even more urgent than the supply of radium itself. It will initiate all negotiations for the constitution and equipment of national radium centers through the medical faculties of the local universities concerned. When the respective claims and requirements of the various radium centers have been considered and assessed by the commission, the allocation of the national supplies of radium will be commenced. Orders have already been placed by the trust for 10 g. exclusive of the 4-g. bomb, and it is anticipated that the whole of this should be available before the autumn of 1930. It has been decided to instal a radon plant at the National Physical Laboratory for the purpose of supplying (under proper safeguards) radon to hospitals or other institutions which otherwise could receive no direct assistance from the commission for radium therapy.—*Science*

New Hormone. Prof. J. B. Collip, of McGill University, has, it is announced, isolated in crystalline form a new hormone from the placental gland. The hormone has an effect somewhat like that of the anterior pituitary gland, and has a remarkable influence on the metabolism and general health of patients who have received the drug.—*Chem. & Ind.*

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is briefly but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Teachers' Associations, or other organizations which are of such a nature as to make them of more than purely local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It is desirable to have a representative appointed to report news regularly. Suitable material sent to the editorial office before the 20th of each month will be published in the following month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the following suggestions are followed, however, the necessity for such action will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in chemical education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honors and awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations. Where original or unusual features are included, it is desirable that they be described in some detail.

The Franklin Institute. The Medal Meeting of the Franklin Institute was held on May 21, 1930. Among other awards, the Levy Medal was presented to DR. FLOYD KARKER RICHTMYER, professor of physics, Cornell University, and the Franklin Medal and Certificate of Honorary Membership were presented to SIR WILLIAM HENRY BRAGG, director of the Royal Institution of Great Britain, London, England. A paper on "The Meaning of the Crystal" was presented by Sir William Bragg.

National Academy of Sciences. According to *Science Service*, recognition for notable scientific accomplishment was accorded by the National Academy of Sciences, at its closing session in Washington, through the award of medals to five prominent American and foreign scientists, and the election of fifteen men to membership.

New members elected include PROF. C. A. ADAMS, electrical engineering, Harvard University; DR. J. W. ALEXANDER, mathematics, Princeton University; DR. EUGENE T. ALLEN, geophysics, Carnegie Institution of Washington; PROF. HARRY BATEMAN, mathematics, California Institute of Technology; DR. ISAIAH BOWMAN, geography, American Geographical Society, New York; DR. G. P. CLINTON, botany, Agricultural Experiment Station, New Haven, Conn.; DR. WILLIAM W. COBLENTZ, physics, U. S. Bureau of Standards; DR. P. S. EPSTEIN, mathematical physics, California Institute of Technology; DR. VERNON L. KELLOGG, biology, secretary of the National Research Council; DR. F. G. KEYES, chemistry, Massachusetts Institute of Technology; DR. K. S. LASHLEY, psychology, Institute of Juvenile Research, Chicago; DR. BERTHOLD LAUFER, anthropology, Field Museum of Natural History; DR. S. C. LIND, chemistry, University of Minnesota; DR. FRANK E. ROSS, astronomy, Yerkes Observatory; and DR. A. H. STURTEVANT, biology, California Institute of Technology.

DR. R. A. MILLIKAN of the California Institute of Technology was reëlected foreign secretary of the Academy for a term of four years. DR. K. T. COMPTON of Princeton University was elected member of the governing council, to succeed DR. GEORGE E. HALE, retired. DR. J. MCKEEN CATTELL, publisher of *Science*, *Scientific Monthly*, and other scientific periodicals and books, was re-elected to succeed himself.

American Association for the Advancement of Science. The Committee on the Place of Science in Education of the A. A. A. S. has announced an essay contest for high-school students, entries for which must be in the hands of the committee by December 10, 1930. The essays will cover a wide range of topics. The winning papers will bring their authors a certificate of achievement from the A. A. A. S. and a recommendation from the committee for a scholarship in the colleges or universities which the students may choose to enter. However, the unique feature of the awards is the distribution of twenty prizes, ranging from $50 to $200, which will be made available to the schools which the winning authors attend, and which will be devoted to the purchase of books to be given in the name of the winners to their school libraries. Further information regarding the contest may be secured from the Chairman of the committee, DR. OTIS W. CALDWELL, 433 West 123rd Street, New York City.

Battelle Memorial Institute. Battelle Memorial Institute announces the appointment of MR. CLYDE E. WILLIAMS as assistant director. This Institute is a foundation devoted to research in the fields of metallurgy and fuels and provides facilities for coöperative research projects of industry. Mr. Williams, who became a member of the staff in September, 1929, was previously chief metallurgist for the Columbia Steel Corporation of San Francisco. For many years Mr. Williams was with the U. S. Bureau of Mines and is best known for his work on sponge-iron, electric furnace cast iron and refractories.

In 1924 Mr. Williams accompanied DR. H. FOSTER BAIN to the Argentine to report for the Argentine government on the feasibility of developing the iron, steel, and coal industries in that country.

Mr. Williams is also a member of the subcommittee on Metallurgy of the Chicago World's Fair Centennial Celebration.

J. T. Baker Chemical Company's Research Fellowship in Analytical Chemistry. The J. T. Baker Chemical Company's Research Fellowship in Analytical Chemistry, Eastern Division, 1930–31, has been awarded to MR. REUBEN ROSEMAN who will work at The Johns Hopkins University under the direction of PROFESSOR W. M. THORNTON, JR., upon a problem relating to the use of powerful reducing agents in volumetric analysis. Mr. Roseman studied at the Massachusetts Institute of Technology during 1926–27 and graduated at The Johns Hopkins University, June, 1929. Mr. Roseman, since his graduation, has assisted Professor Thornton in an investigation of the quantitative determination of potassium, and DR. P. BORGSTROM in work dealing with the quantitative determination of mercaptans.

Carnegie Institute of Technology. Gifts totaling $425,000 to extend over a five-year period for the establishment and maintenance of a coal research laboratory at the Carnegie Institute of Technology were announced yesterday by Dr. Thomas S. Baker, president of the institution.

The Buhl Foundation of Pittsburgh is the largest single donor to the project, contributing $50,000 at the outset for the equipment of the laboratory, and $25,000 a year for five years for a program of pure research. The gift of the Buhl Foundation is made with the stipulation that certain additional amounts shall be secured from other sources. This condition has now been met through the cooperation of six American concerns who are the other contributors to the project that has been outlined by Dr. Baker. The firms coöperating are the United States Steel Corporation, the General Electric Company, the Koppers Company, the New York Edison Company, the Standard Oil Company of New Jersey, and the Westinghouse Electric and Manufacturing Company. These six corporations will contribute a total of $50,000 a year for five years for the maintenance of the laboratory.

The plan for the new laboratory will go into effect July 1, 1930. The laboratory, according to Dr. Baker, will be a part of the Carnegie Institute of Technology, and will undertake fundamental research in coal and the products which may be obtained from it. The Carnegie Institute of Technology will organize graduate courses for the training of students in fuel technology in connection with the research laboratory, with the research staff giving instruction.

Dr. Baker has long been interested in the study of coal and the use of its products. He was the organizer of the First and Second International Conferences on Bituminous Coal that attracted famous scientists from abroad, and drew the attention of the world to Pittsburgh. A third conference will be held in Pittsburgh at the Carnegie Institute of Technology in November, 1931.

German Bunsen Society. The 35th general meeting of the Deutsche Bunsen-Gesellschaft for experimental physical chemistry, the leading German society in the physico-chemical sphere was held at Heidelberg near the Rhine river from May 28 to June 1, 1930.

Spectroscopy and formation of molecules was the principal theme under deliberation.

Willard Gibbs Medal. *See* **The University of Chicago.**

John Simon Guggenheim Memorial Foundation. The Board of Trustees of this foundation has announced the 1930 appointments to fellowships. Eighty-four awards have been made, including seventeen renewals. Besides creative work in literature, sculpture, painting, and music; literary criticism; classical tongues; history and economics; a number of awards have been made in various fields of science, including the following fellowships in chemistry: DR. SIMON FREED, research associate in chemistry, University of California: Magnetic and spectroscopic observations of atomic and molecular structure, at the University of Leyden; DR. ARTHUR GROLLMAN, associate in physiology, The Johns Hopkins University School of Medicine: Researches in the field of physical chemistry as applied to physiology and medicine, in Copenhagen, London, and Berlin; DR. THOMAS E. PHIPPS, associate professor of chemistry, University of Illinois: Studies in the field of molecular rays, at the University of Hamburg; and DR. E. L. SKAU, assistant professor of physical chemistry, Trinity College, Hartford, Connecticut: Research on methods of purification of organic compounds [see THIS JOURNAL, **7**, 1431–2 (June, 1930)].

The Committee of Selection in the United States included PRESIDENT FRANK AYDELOTTE of Swarthmore College, PROFESSOR LAFAYETTE B. MENDEL of Yale University, PROFESSOR LOUISE POUND of the University of Nebraska, PROFESSOR E. B. WILSON of the Harvard School of Public Health and president of the Social Science Research Council, and PROFESSOR F. J. E. WOODBRIDGE of Columbia University.

Mellon Institute of Industrial Research. The third annual supplement to Bibliographic Bulletin No. 2 of Mellon Institute of Industrial Research, Pittsburgh, Pa., has just been issued. This publication lists 7 bulletins, 50 research reports, 59 other papers, and 16 domestic and 15 foreign patents by members of the Institute during the calendar year 1929. The total contributions to the literature, for the 18 years ended January 1, 1930, have been as follows: 15 books, 96 bulletins, 528 research reports, 849 other articles, 407 U. S. patents, and 295 foreign patents.

Complimentary copies of the third supplement, as well as of the preceding numbers of the series, will be sent to laboratory directors, librarians, science teachers, and institutional heads who request them.

Theodore William Richards Medal Fund. The Northeastern Section of the

A. C. S. is accumulating a fund of $10,000 for the establishment of a gold medal to commemorate the fundamental contributions to chemistry made by Theodore William Richards. The medal will be awarded at intervals of two or three years for conspicuous achievement in chemistry. A committee consisting of DR. LYMAN C. NEWELL, Boston University, *Chairman;* DR. ARTHUR D. LITTLE, of Arthur D. Little, Inc., Cambridge, Massachusetts, and DR. JAMES F. NORRIS, Massachusetts Institute of Technology, Cambridge, has been appointed by the section to receive contributions for the fund.

Chemistry Teachers' Club of New York. HAROLD A. WHITNEY of De Witt Clinton High School was elected to succeed HERMAN M. CAMPSEN, JR., of Brooklyn Technical High School as president of the Chemistry Teachers' Club of New York at the club's annual dinner at City College, May 16th.

Other officers elected were EARL M. WASHBURN of Brooklyn Technical High School, *vice-president*, and EVAN C. BRUNNER, of Great Neck High School, *treasurer*. The election of secretary was postponed until the new school year.

DR. GEORGE W. WILSON spoke on "Some Recent Developments in Chemistry by the United States Army," and G. EDWIN WHITE spoke on "The Development of Chemical Engineering at City College."

Seventh Annual Chemistry Contest. The Seventh Annual Chemistry Contest for Rhode Island High School students was held at Kingston, May 10, 1930. [See THIS JOURNAL, **7**, 1203 (May, 1930).]

Rogers High School finished first, Providence Technical High School, second, and La Salle Academy, third. VINCENT HACKETT of Rogers, JOHN BURTON of Burrillville, and ARTHUR LEYDON of Technical High School were, respectively, the highest scorers. DOROTHY CARPENTER of Burrillville made the highest score attained by a girl, while RUTH HILTON of Technical High won the second prize for girls.

The Rogers High School team received the Williams cup, a silver trophy given by ISRAEL KAPLAN, '20, Rhode Island State College.

The Southwest Virginia Chemists' Club. The Southwest Virginia Chemists' Club composed of members of the Virginia section of the American Chemical Society in southwest Virginia was organized in the fall of 1927 through the efforts of Dr. Harry I. Johnson of Roanoke College, Salem, Virginia.

The membership of the club includes the chemistry faculties of the colleges and universities and the members of the laboratories of the chemical industries within a radius of one hundred miles west of Roanoke, Virginia, and fifty miles east of the city. Persons from the following colleges and industries have attended the meeting this year: Virginia Polytechnic Institute, Roanoke College, Hollins College, Virginia College, Radford State Teachers College, Washington and Lee University, Virginia Military Institute, Randolph-Macon Women's College, the Viscose Corporation of Virginia, the Salem Tannery, the General Chemicals Company, the city water works, and the Board of Health of Roanoke.

Two meetings of the club have been held at Hollins College during the academic year 1929–1930; one in October, the other in January. The October meeting was a joint meeting of the club with the Virginia Section of the A. C. S. About eighty members of the club and guests attended the dinner given at the College. Approximately three hundred persons heard the address on "Radioactivity" by DR. GEORGE WILLIAM GUY of The College of William and Mary which was given in the Hollins Little Theater at 8.15 P.M.

DR. JAMES LEWIS HOWE, of Washington and Lee University, spoke at the January meeting of the club on the subject of "Platinum in Industry."

The club has been instrumental in bringing the following out-of-state speakers to address it at meetings in the various colleges within the group: DR. MARSTON T. BOGERT, DR. HARRISON E. HOWE, and DR. WILLIAM J. SHOWALTER.

Cooper Union. DR. KARL F. HERZFELD, professor of physics at The Johns Hopkins University, will lecture at the Cooper Union in New York City on each Tuesday evening during the next college year. These lectures will constitute a survey of the field of modern physics and several evenings will be given to each of the following topics: Crystal Structure, Absorption and Emission of Light in the Quantum Theory, Photochemistry, Dielectric Polarization and the Structure of Molecules, Outline of Atomic Structure, Band Spectra, and the Structure of Gas Molecules. The lectures have been arranged by the departments of chemical engineering and physics at the Cooper Union.

Another course of lectures will be given by DR. ALBERT B. NEWMAN, professor of chemical engineering. The general subject of these lectures will be the Unit Operations of Chemical Engineering, including the flow of fluids, heat transmission, evaporation, distillation and absorption. The evening of the week has not yet been selected.

Both of these courses will be open without the payment of fees to interested persons who have had the necessary mathematical preparation. These lectures form part of a program of advanced courses being offered at Cooper Union for the benefit of those industrial scientists and engineers who desire to keep abreast of the newest developments affecting their fields of work. Descriptive circulars and application blanks will be ready in August, and those desiring to be placed on the mailing list should address DR. ALBERT B. NEWMAN, professor of chemical engineering, Cooper Union, New York City.

Albright College. DR. J. BENNETT HILL, chief chemist of the Atlantic Refining Co., and chairman of the Petroleum Division of A. C. S., delivered two addresses at Albright College on April 24th. In the afternoon Dr. Hill spoke to the students of chemistry on the topic "Gasoline." In the evening he spoke on "The Petroleum Industry" before a meeting of Reading Chemists. This meeting was sponsored by PROFESSOR GRAHAM COOK of the department of chemistry. There were 43 representatives of local industries and schools present. Plans were discussed for the formation of a permanent organization to be a part of the Philadelphia section of the A. C. S.

The new science building was dedicated on May 16th during a meeting of the Association of College Presidents of Pennsylvania, held at Albright College. The principal speaker was DR. J. H. PENNIMAN, provost of the University of Pennsylvania.

Antioch College. DR. C. S. ADAMS, professor of chemistry, has recently been appointed director of the new Antioch Industrial Research Institute, Incorporated, for the investigation of chemical and physical problems.

DR. AUSTIN M. PATTERSON was elected vice president of Antioch College at a meeting of the trustees, May 2, 1930.

Athens College. MISS ALICE HEAP represented Athens College at the recent dedication of the science laboratory of the new $30,000 building of Trinity School for Negroes, Athens, Alabama. The school was established by the American Missionary Society for the education of adults on the site of the Athens Fort in May, 1865.

Boston University. DR. J. PHILIP MASON has been promoted to assistant professor of chemistry. He plans to study chemical microscopy this summer at Cornell University.

DR. LYMAN C. NEWELL is chairman of

a committee of the Northeastern Section of the A. C. S., appointed to raise a fund of $10,000 to establish a gold medal in honor of the late Theodore William Richards.

Centre College. The seventeenth annual meeting of the Kentucky Academy of Science was held at Centre College, Danville, Ky., on May 3, 1930.

The meeting was called to order by the president, DEAN FRANK L. RAINEY of Centre College, who delivered an address on "The Teaching of Science in Colleges of Liberal Arts."

The following officers were elected: *President*, V. F. PAYNE; *Vice President*, MRS. CHAS. C. COOPER; *Secretary*, A. M. PETER; *Treasurer*, W. S. ANDERSON.

The principal address was an illustrated lecture by DR. A. M. REESE, West Virginia University, on "The Habits of the American Alligator."

Clemson College. Early in June, DR. CHAS. E. MULLIN, head of the Division of Textile Chemistry and Dyeing at Clemson College Textile School, South Carolina, sailed for Europe, where he will continue his study of foreign textile schools.

A paper, entitled "The Relation of Cotton to Synthetic Fibres," given by DR. MULLIN at the Symposium on "The Relation of Cotton to Chemistry" at the Atlanta meeting of the A. C. S., will be published in the August issue of THIS JOURNAL.

College of Charleston. Construction has begun on a new wing for the main building which will include additional laboratory and classroom space for the department of chemistry and physics. The building addition, which is the second of the sort in the past century, is badly needed, the student enrolment of the College having trebled during the past decade.

The Pre-Medical Club of South Carolina, a student organization, has recently established a medal to be offered annually to the student whose record in science is adjudged by the heads of the scientific departments to be most distinguished.

College of the City of Detroit. MR. ALEXANDER J. STIRTON, who completed the work for graduation last semester, has been appointed Junior Chemist in the Bureau of Chemistry and Soils, Washington, D. C. Mr. Stirton won his appointment through competitive examination under the Civil Service and joined the staff in Washington on April 18th.

College of the Pacific. DR. B. S. HOPKINS, of the University of Illinois, and MRS. HOPKINS visited the College of the Pacific, Stockton, California, on April 29th. Dr. Hopkins addressed the students and staff of the department of chemistry on "Search for a Chemical Element," describing the research which led to his discovery of the element illinium, and illustrating his lecture with lantern slides and samples of the salts of the rare earths.

Cornell College. The chemistry major students of the class of '30 of Cornell College have been placed for the coming year: HARRY G. DAY, Certified Milk Producers Association fellowship in the School of Hygiene and Public Health at The Johns Hopkins University; TOM L. JACOBS, assistant at Cornell University, to work in the field of physical chemistry; ERWIN L. CARPENTER, assistantship at Columbia University, to work in organic chemistry; ERNEST K. NIELSEN, assistant at Purdue University to work in organic chemistry; GENEVA E. GOODRICH, appointment in biological chemistry in the School of Medicine, University of Iowa. CHARLES THORPE goes to the Humble Oil and Refining Company, of Houston, Texas, and WILLARD C. STEWART to the Newport Chemical Works, dye manufacturers, Milwaukee, Wisconsin.

LYNNVILLE CARPENTER, Cornell College, '28, who has been chemist at the Forest Paper Company of Madison, Wisconsin, has gone to Rumford, Maine, to assume the duties of chemist to the Oxford Paper Company.

Creighton University. MR. DANIEL P. NOLAN, Ch.E., assistant professor of chemistry in the College of Arts and Sciences, has been granted leave of absence for one year, to accept a fellowship at Notre Dame University. He will continue work toward the Ph.D. degree.

MR. JAMES W. VAVERKA, B.S., instructor in chemistry, has received a fellowship to Holy Cross College, Worcester, Mass., and has also been given leave of absence to avail himself of the opportunity to obtain the degree of M.S.

DEAN HOWARD C. NEWTON, of the College of Pharmacy, attended the meeting of the American Association of Colleges of Pharmacy, in Baltimore, the early part of May. Dean Newton is chairman of the section on Practical Pharmacy and Dispensing of the American Pharmaceutical Association.

Galloway College. On May Day, the annual Homecoming Day at Galloway, MISS GERTRUDE WESTMORELAND was presented with the check for $200 awarded her in the recent Prize Essay Contest of the A. C. S. Approximately 1500 people were present.

On Tuesday, May 20th, the organic class lectured to the freshman students in chemistry on the Chart of the Atoms. Following the lecture the freshmen were hostesses to the lecturers at a picnic dinner in the laboratory of Science Hall.

Harvard University. LOUIS FREDERICK FIESER has been appointed assistant professor of chemistry of Harvard University. Professor Fieser received the degree of B.A. from Williams College in 1920, and Ph.D. from Harvard University in 1924. He spent a year in European laboratories as Frederick Sheldon Traveling Fellow and, upon returning to this country, became a member of the department of chemistry of Bryn Mawr College. His research work has dealt for the most part with oxidation potentials and anthraquinones.

OSCAR KNEFLER RICE has been appointed instructor in chemistry. Dr. Rice graduated from the University of California in 1924 and received his doctor's degree from the same institution in 1926. Since that time he has been at California Institute of Technology and at Leipzig as National Research Fellow. He has published numerous papers on the theory of unimolecular reactions and allied topics.

Haverford College. MR. ALEX N. FRASER, Dalhousie University, Halifax, N. S., and MR. RALPH O. SHERBERG, Northwestern University, Evanston, Ill., have been appointed assistants in chemistry for 1930–1931. MR. ROBERT MELAMPY, Wilmington College, Wilmington, Ohio, has been appointed to a graduate fellowship in chemistry.

Howard College. A sabbatical leave of absence for the session 1930–31 has been granted DR. JOHN R. SAMPEY, who will spend the year in physical-organic research at The Johns Hopkins University. PROFESSOR FRANKLIN P. LASSETER, who returned this year from a fifteen months' leave at Columbia University, has been appointed acting head of the department.

Illinois College. MR. W. O. MILLIGAN, who has acted as laboratory assistant, has been granted a graduate fellowship at Rice Institute, Houston, Texas, for 1930–31. He recently passed the government examination for Junior Chemist.

MR. W. I. PATTERSON, '30, has been granted a graduate scholarship in chemistry at the University of Illinois for the coming year.

The chemistry department recently received a gift of $1000 for the purchase of books.

The Johns Hopkins University. On May 9th, DR. F. G. COTTRELL, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, spoke on "Research at the Nitrogen Fixation Laboratory," and on May 16th, DR. F. C. FRARY, of the Aluminum Company of America, lectured on "The Development of Chemical Research at the Aluminum Company of America." Both of these lectures were given under the Dohme Lectureship established by DR. A. R. L. DOHME of Baltimore.

On May 23rd, SIR WILLIAM BRAGG, Director of the Royal Institution of Great Britain, gave a lecture on "The Structure of Organic Crystals."

The 129th meeting of the Maryland Section of the A. C. S. was held on Friday, May 23, 1930, at 8.15 P.M. in Remsen Hall, The Johns Hopkins University. The following scientific program was given by the graduate students of the department of chemistry, The Johns Hopkins University: R. BULKLEY, "Viscosity of Liquids in Fine Capillaries." H. T. BYCK, "Decomposition of Organic Molecules in a Molecular Beam." JAMES CURRY, "Desorption of Gases from Plane Glass Surfaces." T. G. DJANG, "Reactions of Mercuric Chloride with Oxalates." W. C. EICHELBERGER, "Osmotic Pressure of Dilute Benzene Solutions by the Porous Disc Method." L. M. ELLIS, JR., "Reactions of Mercaptans." L. KILGORE, "Alcohol-Free Alk-oxides." LAURA KREJCI, "Studies on Solid Adsorption." J. A. MITCHELL, "Silica Gel as a Catalyst in Organic Reactions." J. MCGRAW, JR., "Heat Capacity of Nitrogen Pentoxide." R. H. SMITH, "Specific Heats of the Phenyl Derivatives of Ethane and Some Related Compounds." J. F. WEILER, "Mechanism of Decomposition of Acetone in the Gas Phase."

Kansas State Agricultural College. The local section of the A. C. S. held a joint meeting with the Kansas State Chapter of the Sigma Xi, Friday, May 2nd, at 8.00 P.M. DR. C. A. MILLS, M.D., Ph.D., of the Medical School of the University of Cincinnati, was the speaker. The title of his address was "Effect of Climate on Metabolism and Metabolic Diseases." The lecture was illustrated with lantern slides and dealt with a number of phases of the subject such as adrenal deficiency in China and its relation to moisture and temperature, and the effect of moisture and heat in depressing fertility.

Dr. Mills was the guest of honor at the annual Sigma Xi banquet held in Thompson Hall before the lecture.

Keuka College. PROFESSOR F. MARION LOUGEE, of the department of chemistry of Keuka College, is on leave of absence for the second semester and is pursuing research in London. During the summer she will travel extensively on the continent. DR. MINNIE A. GRAHAM is in charge of the department during Dr. Lougee's absence.

Knox College. During April and the early part of May, the department of chemistry of Knox College has had upon the campus DR. ELLWOOD HENDRICK, Curator of the Chandler Museum of Chemistry of Columbia University. Dr. Hendrick delivered four lectures each week upon topics related to applied chemistry and to unsettled problems in chemistry. Dr. Hendrick came to the college under the auspices of the Honnold Lectureship, endowed by MR. WILLIAM L. HONNOLD, of Los Angeles, California.

On the evening of April 26th, the Illinois-Iowa Section of the A. C. S. met with the Knox County Academy of Science in Beecher Chapel of Knox College. The speaker was DR. E. R. DARLING, of the Corn Products Company, Danville, Illinois. The subject of the address was "The Uses of Farm Waste." The speaker dealt especially with the manufacture of paper pulp from corn-

stalks. Two reels of films illustrated the talk.

Marquette University. DR. JOHN R. KOCH, head of the chemistry department, discussed "Current Rectifying Properties of Metallic Salts in Contact with Metals," and PROFESSOR GEORGE A. HERRMANN presented data dealing with the question, "Does the Acquisition of High-School Chemistry Influence the Student's Grade Obtained in College Chemistry—An Analysis of Freshman College Chemistry Grades" at the Mid-West Regional Meeting of the A. C. S., May 8th to 10th.

The regular summer session at Marquette University will begin June 19th and will terminate August 1st, at which time two semesters of inorganic chemistry, including qualitative analysis, two semesters of quantitative analysis, and the first semester of organic chemistry will be offered. Graduate courses will be made available by special arrangement.

The final meeting of the year of the Marquette University Chemistry Society featured three films, provided through the courtesy of the General Electric Co., entitled: "The Benefactor," "Beyond the Microscope," and the "World of Paper." Recently this society held its annual banquet. DR. WILLIAM W. BAUER, research chemist for the Pittsburgh Plate Glass Co., was the guest and speaker of the evening.

Marywood College. An exhibition of visual aids in the teaching of science was held during the last week of April. Many interesting exhibits were made and set up by the students, who also demonstrated to several hundred visitors the use of the motion picture machine, the stereopticon, the micro-projector, the still film and opaque attachments, and the method of making lantern slides.

"Inadequate Proteins," a monograph prepared by the Food Chemistry Group, was issued during May. Albino rats were used for the experiments.

McKendree College. DR. H. W. GOULD, a former instructor in the Department here and now at the Northern Illinois Teachers' College, was recently initiated into the local chapter of Sigma Zeta, honorary science fraternity.

VERNAL R. W. HARDY, holder of the McKendree College Scholarship at the University of Illinois, has been awarded a Second-Year Scholarship for 1930–31 at the University.

The Peter Akers Scholarship in Chemistry has been awarded for the coming year to WILLIAM O. LORY of East St. Louis. This scholarship, named in honor of the first president of McKendree College and founder of the department, is administered by his great-grandson, J. R. AKERS, chief chemist at the Aluminum Ore Company of East St. Louis.

Missouri School of Mines and Metallurgy. At the meeting of the Ira Remsen Society on April 28th, DR. R. C. SHUEY, Development Chemical Engineer for the Bakelite Company, gave a talk illustrated with moving pictures and Bakelite products. On the evening of May 7th, DR. HALL, research chemist for the Mallinckrodt Chemical Co., of St. Louis, presented a paper entitled, "The Lead Content of Uranium Ore and the Age of the World."

WM. ODE, who has been assistant in analytical chemistry for the past year, has accepted a position with the U. S. Bureau of Mines as assistant chemist. He will report for duty on June 1st. P. H. DELANO, who received his M.S. degree in chemical engineering this spring, will take Mr. Ode's place in the department as assistant in analytical chemistry.

MR. RALPH C. SHUEY, development chemical engineer of the Bakelite Corporation, gave an address before the local group on "Bakelite," on April 28, 1930.

On May 7th, DR. LAWRENCE P. HALL, research chemist, Mallinckrodt Chemical Company, discussed "The Lead Content of Uranium Ores and the Age of the Earth."

DR. GEORGE L. CLARK, professor of

chemistry, University of Illinois, addressed the members of Sigma Xi on Tuesday, May 20th. His subject was "Beyond the Microscope."

Oberlin College. On May 14th, PROFESSOR FAJANS, of the University of Munich, lectured before Oberlin's department of chemistry.

On May 5th, PROFESSOR HARRY N. HOLMES, of the department, lectured at Yale and on May 23rd before the Charleston (W. Va.) Section of the A. C. S. on "Interfacial Adsorption."

The second edition of Professor Holmes' "General Chemistry" is recently off the press.

PROFESSOR W. H. CHAPIN returned in June from his leave of absence in California, very greatly improved in health. DR. WENDELL NIEDERHAUSER, who took his place during the year, joins the faculty of Williams College. DR. A. L. ELDER, who has for two years been the Charles M. Hall research instructor, joins the faculty of Syracuse University. He is succeeded in Oberlin by DR. HENRY LEICESTER of Stanford University.

EUGENE SENSEL, of Oberlin College, won one of the six prizes of five hundred dollars each in the National Prize Essay Contest for Freshmen conducted by the A. C. S.

The Ohio State University. On Monday, May 5th, DEAN WM. MCPHERSON, president of the A. C. S., addressed the faculty and students of chemistry of the University of West Virginia, at Morgantown.

On April 17th, PROFESSOR WM. LLOYD EVANS, of the department of chemistry, addressed the Michigan State College Section of the A. C. S. on "Some Recent Advances in Carbohydrate Chemistry."

The Wittenberg chapter of the Theta Chi Delta Fraternity held its annual High-School Chemistry Contest at Wittenberg on May 10th. The first prize was $250. Following the contest the students were addressed by PROFESSOR WM. E. HENDERSON of The Ohio State University.

PROFESSOR KASIMIR FAJANS, of the University of Munich, addressed the Columbus Section on May 12th and 13th. The subjects of his lectures were: "The Absorption of Ions on Crystals and Their Photochemical and Analytical Applications"; "The Deformation of Ions in Crystals and Molecules"; and "Optical Investigations on Solutions of Strong Electrolytes."

It has been the custom of the Columbus Section to hold one annual meeting at one of the colleges or universities other than The Ohio State University within the confines of the Section. This year the department of chemistry of the Ohio Wesleyan University was host to the Section on May 21st. MR. H. E. OTTING, of the Moores and Ross Milk Company of Columbus, gave a lecture on "Milk." This part of the program was followed by a movie. On the way to Delaware the Section was the guest of PROFESSOR H. T. STETSON of the Perkins Observatory.

For several years, the Lambda chapter of the Alpha Chi Sigma Fraternity has awarded the cup known as the Edward Williams Morley cup to the freshman student having made the highest average up to the date of the award in first-year chemistry. This year the cup was awarded to MR. CLARENCE W. ASSENHEIMER of Bucyrus, Ohio.

The Eta chapter of the Phi Lambda Upsilon Fraternity has an annual award to the sophomore having the best record in quantitative analysis. The recipient was DONALD E. HULL of Crooksville, Ohio. Last year Mr. Hull was awarded the Alpha Chi Sigma scholarship cup.

PROFESSOR J. B. BROWN, of the Ohio State University, addressed the Mercator Club on April 22nd. His discussion was "Chemical Predestination." On May 6th, a joint meeting of the Mercator and Optimists Clubs was held and a lecture with demonstrations on "Some of the Newer Uses of Liquid Air," was given by PROFESSOR J. E. DAY.

On May 2nd, PROFESSOR EDWARD

MACK, JR., addressed the Ohio Northern Section of the A. C. S. on the "Size and Shape of Molecules." Recently Dr. Mack was made one of the members of the new Scientific Advisory Board established by the Westinghouse Research Laboratories.

PROFESSOR ARTHUR J. CLARK, head of the department of chemistry of Michigan State College, was a recent visitor to the department of chemistry.

The biennial Engineers' Day was on May 16th this year. The chemical engineering students had as a part of their exhibit the following items: The equipment machinery of the department; chemical warfare service display; the refining of petroleum by the Pure Oil Company; name plates and ornamental metal works by the D. L. Auld Company; condiments of the Capitol City Products Company; the manufacture of oilcloth by the Columbus Coated Fabric Corporation; and displays of other industrial products.

MR. RALPH SHAFOR, class of '14, who for several years was director of research of the Great Western Research Refining Company, Denver, Colorado, has now become consulting engineer for The Dorr Company, New York City.

During the Atlanta meeting of the A. C. S., PROFESSOR J. R. WITHROW took an automobile trip through the phosphate workings and sponge industry of Florida. On May 5th, Professor Withrow addressed the Engineers' Club of Columbus, on the "History and Activities of the American Engineering Council on National Affairs." He is a member of the Assembly of the American Engineering Council and has served three terms as director for the Council of Region Number 2, including New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, West Virginia, and Ohio.

Ohio Wesleyan University. DR. HARRY F. LEWIS, head of the department of chemistry at Ohio Wesleyan University, has resigned his position in order to accept the position of professor of organic chemistry in the Graduate School of the Institute of Paper Chemistry at Appleton, Wisconsin. DR. W. A. MANUEL, who is at present professor of inorganic chemistry at Ohio Wesleyan, has been named the successor of Dr. Lewis as head of the department.

On May 15th, Dr. Lewis addressed the Ohio Northern Section of the A. C. S., on the subject, "Some Recent Advances in Organic Chemistry."

The May 21st meeting of the Columbus Section of the A. C. S. was held at Ohio Wesleyan University. The meeting was preceded by a dinner and by a trip to Perkins Observatory, of Ohio Wesleyan University, in which there is soon to be installed the new American-made 69-inch reflector, produced by the U. S. Bureau of Standards. The speaker for the meeting was MR. H. E. OTTING, of Columbus, and his topic was "Milk." The lecture was illustrated by moving pictures.

Rensselaer Polytechnic Institute. DR. H. S. VAN KLOOSTER, of the department of chemical engineering, will spend the summer in Holland.

The annual dinner of the Rensselaer Chapter of Sigma Xi was held in Russell Sage Dining Hall on the evening of May 2nd. DR. FRANK PARKER DAY, Chancellor of Union University, delivered an address on "The Influence of Science on Literature."

DR. H. M. FAIGENBAUM will be in charge of the chemical work of the New York State Biologic Survey this summer. The current project includes the St. Regis and Grasse watersheds.

DR. W. P. MASON, professor emeritus of chemistry, has returned to Troy for the commencement exercises of the Institute. Dr. Mason spent the winter in California. He will leave for his home in New Hampshire early in July.

Rose Polytechnic Institute. This Institute held its second biennial Rose

Show on the evenings of April 17th, 18th, and 19th. This was not a flower show, as one might imagine, but an exhibition of the work carried on at the Institute in the several departments of engineering and science. Also there was included, through the courtesy of many of the manufacturing and industrial plants, a number of devices, inventions, machinery, and products newly developed. There were about 300 separate exhibits, of which 33 were shown in the department of chemical engineering.

The basic idea in the chemistry and chemical engineering exhibits was to show many of the applications of chemistry to industry. It included demonstrations and exhibits showing the manufacture of such things as rayon, bakelite, and other plastics; cement, glass, paint, dyes, and chemicals; the softening of water, the refining of oils, the production of paper from cornstalks, the electrolytic production of paints, of pharmaceuticals, of carborundum; electroplating; production of metals and alloys; colloids, their properties and uses; the various products obtained from corn.

As evidence that people are attracted by other things than athletic spectacles, it may be mentioned that the Institute was visited by over six thousand people during the show.

St. Bonaventure's College. St. Bonaventure's College is now introducing a group of courses, in junior and senior years, leading to the degree of Bachelor of Science in Petroleum Engineering.

The courses in this group include engineering, geology, physics, chemistry, mathematics, and drawing.

A course in Petroleum Chemistry was given in the second semester of the present year. This course was offered in two sections, one intended primarily for college students, and the other an evening course.

State University of Iowa. DR. ROBERT RIEDER, of Graz, Austria, who has been International Research Associate in the chemistry department for the present year, left Iowa City on May 7th. After traveling in California, he will return to his home in Graz.

PROFESSOR EDWARD BARTOW attended the Regional Meeting of the A. C. S. at Milwaukee on May 8th.

MR. EDWARD W. NEUMAN, who is a candidate for the Ph.D. this summer, with major in analytical chemistry, has been awarded a National Research Council Fellowship. He will do his research work on "Solubility of Inorganic Precipitates in Various Aqueous Solvents of Strong Electrolytes and Its Relation to Modern Theories of Solution," under the direction of PROFESSOR A. A. NOYES at the California Institute of Technology, Pasadena. Mr. Neuman has been research assistant in chemistry during the present year.

MR. WALTON B. TANNER, who is also a candidate for the Ph.D. with major in physical chemistry, has accepted a position with the Roessler & Hasslacher Chemical Co. at Niagara Falls, N. Y.

Temple University. PROFESSOR J. HOWARD GRAHAM, one of the contributing editors of THIS JOURNAL, has accepted the position of professor of physics and associate professor of organic chemistry, at the School of Pharmacy of Temple University, and will enter upon his new new duties next fall. Professor Graham is now at Central High School, Philadelphia, Pennsylvania.

The University of Chicago. The Seminar Club held two meetings during the month of May. The May 7th meeting was conducted by DR. W. C. PIERCE who discussed some recent work on the diffraction of X-rays in liquids and in gases. At the meeting held May 21st, DR. W. C. JOHNSON spoke on "Some Recent Problems in Inorganic Chemistry."

DR. T. F. YOUNG lectured before the Michigan State College Section of the A. C. S. on May 1st on "The Heats of Dilution of Strong Electrolytes."

PROFESSOR K. FAJANS lectured in the Kent Laboratory on Friday, May 16th. His subject was "The Deformation of Ions as Shown by Refractometric Data."

The Chicago Section of the A. C. S. presented the nineteenth Willard Gibb's Medal, found by William A. Converse, to DR. IRVING LANGMUIR, of the General Electric Company, on Friday evening, May 23rd, at the Palmer House, Chicago, Illinois. The following program was carried out:

The Willard Gibbs Medal, WARD V. EVANS, *Chairman* of the Chicago Section; The Medalist, KARL T. COMPTON, Princeton University; Presentation of The Willard Gibbs Medal to Irving Langmuir by JULIUS STIEGLITZ, The University of Chicago; What Are Atoms Like?—How Do We Know?—IRVING LANGMUIR; Responses, MARTIN J. INSULL, Middle West Utilities Company, GLENN FRANK, University of Wisconsin, HERMAN N. BUNDENSEN, M.D., Chicago, RALPH E. HEILMAN, Northwestern University.

PROFESSOR H. I. SCHLESINGER has been elected chairman of the Chicago Section of the A. C. S. for the year 1930–31. He succeeds PROFESSOR W. V. EVANS of Northwestern University.

University of Cincinnati. JOHN H. PAYNE and HOKE S. GREENE who received the Ph.D. in June are now with the Roessler Hasslacher Corporation at Niagara Falls. Dr. Payne, who has been appointed exchange student, has been granted a leave of absence for one year and will sail for Europe in the fall to enter the laboratory at the University of Munich, where he will work with Professor Wieland.

DR. SAUL B. ARENSON delivered the convocation address to 1500 students of the Eastern Kentucky Normal School, Richmond, Ky., on April 23rd. His subject was "Chemical Research in Industry." He also discussed, with the students particularly interested in chemistry, the opportunities in chemistry and chemical engineering.

The fifth triennial national convention of Iota Sigma Pi (honorary chemical sorority) will be held at the University of Cincinnati on September 6th, 7th, 8th, just preceding the fall meeting of the A. C. S. National President DR. SYBIL WOODRUFF, University of California, will preside. MRS. M. VAN VALKENBURGH HOLT, president of the hostess chapter (Radium), has general charge of the local arrangements.

DR. RALPH E. OESPER spoke at the April meeting of Iota Sigma Pi on "Madame Lavoisier."

The Student Chemist Club has held monthly supper meetings throughout the school year. The speakers were: FRANK J. ANDRESS, "The Milk Problem"; O. C. VON SCHLICHTEN, "Crystallography and Its Application to Chemistry"; C. H. BEHRER, "Problems Confronting a City Chemist"; S. J. M. ALLEN, "Modern Theories of Physics and Their Relation to Chemistry"; A. P. MATHEWS, "Some Problems of Biochemistry."

University of Florida. DR. T. R. LEIGH, head of the department of chemistry and dean of the College of Pharmacy, attended the annual meeting of the American Pharmaceutical Association held in Baltimore May 5th to 10th. Dr. Leigh is chairman of the Committee on Curriculum and Teaching Methods of the Association. He also attended the U. S. Pharmacopeia Convention held in Washington, May 12th to 17th.

The summer session of the university opened June 16th and will close August 8th. DR. T. R. LEIGH and DR. R. C. GOODWIN will offer courses in general chemistry, qualitative and quantitative analysis, organic chemistry, and research. Graduate courses will be offered upon demand. PROF. A. P. BLACK will offer, as in previous summers, a two-semester orientation course in general natural science. He will be assisted by DR. F. H. HEATH, who will also offer a course in materials and methods in science.

University of Illinois Section, A. C. S. On Monday, May 12th, officers of the local section of the A. C. S. were elected for the coming year as follows: PROF. D. B. KEYES, *chairman;* DR. DANA BURKS, *vice-chairman;* DR. VINCENT DUVIGNEAUD, *secretary;* DR. C. W. STILLWELL, *treasurer;* PROFESSORS ROGER ADAMS, and GEO. L. CLARK, *councilors;* DR. L. L. QUILL, *editor.*

The committee of the Association of Illinois Chemists, chosen to select a memorial for Miss Marion E. Sparks, reported at the luncheon meeting of the organization held at Atlanta. The memorial is to be an inscribed bronze tablet in the chemistry library. Miss Sparks had been, before her death last winter, librarian in the chemistry library for a long period of years, and was a devoted friend of all Illinois chemists.

LOUIS A. ASTELL, head of the science department, West Chicago Community High School and member of the Illinois Chemistry Teachers' Association for some time, will take up the duties of a research associate under DR. OTIS W. CALDWELL, director of the Institute of School Experimentation, Teachers' College, Columbia University, next fall.

DR. J. R. JOHNSON, who received his doctorate from Illinois in 1922, and who has been an assistant professor at Cornell University for the past two years, has just been made a full professor and head of the division of organic chemistry at Cornell.

DR. DOUGLAS W. HILL will come to the University of Illinois next year as one of the Commonwealth Fund Fellows. Dr. Hill received his doctorate at Liverpool, and has been located at Bristol University this past year. He will work on chemotherapy under PROFESSOR ROGER ADAMS.

DR. CATHERINE STEELE, who has been at Illinois for the past two years as a Commonwealth Fund Fellow, will study at Harvard next year.

The executive committees of the three divisions, Industrial, Gas and Fuel, and Petroleum, have decided to hold a joint symposium at the Cincinnati meeting of the A. C. S. The symposium is to be on the subject of "High-Pressure Reactions in Industry." PROF. NORMAN W. KRASE, of the chemistry department of the University of Illinois, will direct the preparation of the program.

DR. IRVIN A. KOTEN, who received his doctorate at Illinois in 1924, has accepted a position as professor and head of the department of chemistry at Battle Creek College for the coming year. He has been a professor of chemistry at Illinois Wesleyan University for the past few years.

University of Maryland. Among the recipients of the Ph.D. degree in chemistry in June was OTTO REINMUTH, associate editor of THIS JOURNAL. Prior to the conferring of the degree, he was elected to full membership in the local chapter of Sigma Xi. Dr. Reinmuth's dissertation, "The Nature of Interaction between Hydrous Oxides and Mordant Dyes," was presented at the Seventh Colloid Symposium held at The Johns Hopkins University, June, 1929, and is published in the Colloid Symposium Annual, Volume VII.

University of Missouri. MR. MILTON H. WAHL has received a fellowship at the University of Illinois. He will continue in his present position as graduate assistant during the summer term. MR. JOHN REHNER has received a graduate fellowship at the University of Minnesota, and MR. HAROLD P. BROWN, a fellowship at the University of Nebraska.

MISS MARY DRANE has accepted a position to teach chemistry at Cottey College, Nevada, Missouri.

MR. RALPH FULTON, who has been lecture assistant in inorganic chemistry, has been appointed to a position with the Bakelite Corporation.

MR. CLAUDE ALEXANDER, who will also receive the degree of Master of Arts in June, has been appointed to a

position with the Goodrich Rubber Company.

MR. FRANKLIN JOHNSTON will also be with the Goodrich Rubber Company next year.

A note on the recently published bulletin of the School of Mines and Metallurgy of the University of Missouri will be found on p. 1728.

University of New Mexico. DR. JOHN D. CLARK, professor of chemistry, has been elected president of the Southwestern Division of the American Association for the Advancement of Science. Dr. Clark is a member of the staff of contributing editors of THIS JOURNAL.

University of Tennessee. A petition for a local section of the A. C. S., to be known as the East Tennessee Section with headquarters at Knoxville, was accepted by the Council at the Atlanta meeting on April 7th. At the initial meeting the following officers were elected: *Chairman*, PROF. CHAS. O. HILL, head of the department of chemistry, University of Tennessee; *Vice-Chairman*, MR. MILLARD J. HUGHES, chief chemist, Aluminum Company of America, Alcoa, Tennessee; *Secretary-Treasurer*, PROF. C. A. BUEHLER, University of Tennessee; *Councilor*, PROF. J. C. LOWERY, Knoxville High School. Plans were made for holding meetings monthly.

University of Virginia. DR. CHARLES LEE REESE, graduate of the University of Virginia in 1884 and director of the du Pont Company, was the guest speaker at the final meeting of the Chemical Engineering Society on May 8th. His subject was the "Development of a Chemical Industry," in which he described the growth of the du Pont Company from a small powder mill to the present complicated organization dealing in a wide range of chemical products. Present in the audience was FRANCIS PERRY DUNNINGTON, professor emeritus of industrial and analytical chemistry, in whose classes Dr. Reese sat as a student at this University some 45 years ago.

WILLIAM FENTON ROSS, of Richmond, Virginia, has been announced by the faculty of the school of chemistry as the outstanding junior pursuing a course leading to the degree of B.S. in chemistry or chemical engineering. The Alpha Kappa Chapter of Alpha Chi Sigma will award him a membership in the A. C. S. commencing Jan. 1, 1931, in accordance with the establishment of this annual prize.

At the final business meeting of the school year, held recently at the Cobb Chemical Laboratory at the University of Virginia, the Chemical Engineering Society elected the following officers to serve during the 1930–31 session: *President*, RICHARD W. QUARLES, Richmond, Va.; *Vice-President*, ELLIS H. MCCOY, Charlottesville, Va.; *Secretary*, GEO. R. JONES, Washington, D. C.; *Treasurer*, WM. K. PRICE, New Market, Va.; *Corresponding Secretary*, GEO. A. ROBERTSON, Norfolk, Va.

Upper Iowa University. PROF. L. E. BLACKMAN, head of the chemistry department, attended the forty-fourth annual meeting of the Iowa Academy of Science at Iowa State College, Ames, Iowa, May 2nd and 3rd. Prof. Blackman was elected a fellow to the Academy in 1926.

Prof. L. E. Blackman addressed the Oelwein Science Club, the C-Why-4 Club, at their annual banquet April 28th, on the subject, "Science and Everyday Life."

Valparaiso University. In line with some other institutions, Valparaiso University offers a chemistry-commerce curriculum. The chemistry department has arranged a special course for the seniors taking this curriculum. How this course is conducted is shown by the following example. In the digging operations connected with a plant operated by the father of a senior a certain mineral was found. For the work of the course the

senior will make quantitative analyses of several samples of the mineral; he will determine the extent of the deposit; he will investigate the market for mineral of that kind and quality; he will attempt to determine the cost of production of the mineral; and finally, he will attempt to develop a use for the mineral as a raw material for a chemical product. The last part of the problem will include laboratory work and cost calculations.

Winthrop College. On April 26th, DR. CHAS. E. MULLIN, professor of textile chemistry at Clemson College, addressed several hundred students at Winthrop College on "The Manufacture of Artificial Silk." The lecture was illustrated with samples of cloth from many countries.

PROFESSOR G. G. NAUDAIN, of Winthrop College, will be at New York University this summer.

The new $130,000 social and physical science building which has been erected was formally opened on May 17th.

Central Texas Section, A. C. S. The annual meeting of the Central Texas Section of the A. C. S. was held in the chemistry lecture room of Baylor University, Saturday, April 19, 1930, at 7.30 P.M., PRESIDENT J. C. GODBEY in the chair.

The following papers were presented: "Impressions of the Atlanta Meeting," C. C. HEDGES and A. E. SCHAAR; "A Periodic Table of the Elements," C. W. BURCHARD; "Some Misconceptions of Chemical Warfare," H. R. BRAYTON; "Certain Molecular Rearrangements of Hydrazones and Pyrazolines," J. B. ENTRIKEN; "Nitrite Production in Soils," G. S. FRAPS and A. J. STERGES; "Some Characteristics of the Corrosion Cell: Iron—Aerated-Iron," H. L. LOCHTE.

The fall meeting will be held at Trinity University, Waxahachie, in October, and the next annual meeting in April in Waco.

W. S. MAHLIE, of Fort Worth, was elected president.

Cincinnati Section, A. C. S. A meeting of the Cincinnati Section of the A. C. S. was held on May 14th at 8.00 P.M. in the chemistry building of the University of Cincinnati. PROFESSOR E. M. CHAMOT, of Cornell University, spoke on "The Microscope in the Chemical Laboratory."

Pittsburgh Section, A. C. S. On June 6th, a meeting of the Pittsburgh Section of the A. C. S. was held in honor of the completion of 25 years' service at the University of Pittsburgh by PROFESSOR ALEXANDER SILVERMAN, head of the chemistry department. DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, spoke on "Twenty-five Years of Progress in Chemistry."

Effect of Water on Chemical Reactions. It has been known for some time that certain chemical reactions take place very slowly, if at all, in the absence of traces of water. The earlier experiments of Dixon and of H. B. Baker provided several interesting examples of this phenomenon. For example, a well-dried mixture of carbon monoxide and oxygen does not explode with a weak electric spark, and dry ammonium chloride does not dissociate on heating. In other cases, such as the union of mercury and chlorine, the presence of moisture has little effect. In *Science Progress* for October there is an article on this subject by G. R. Gedye in which recent work is summarized, and the theories proposed to explain the effects are discussed. It is concluded that effects of ionization and of the surface of the vessel may both play a part, although in some cases, such as the union of carbon monoxide and oxygen, there are special mechanisms of a chemical character.—*Nature*

Recent Books

Inorganic Qualitative Chemical Analysis. ALLAN R. DAY, PH.D., Assistant Professor of Chemistry, University of Pennsylvania. First edition, The Chemical Publishing Co., Easton, Penna., 1930. ix + 197 pp. Tables. 15 × 23 cm. $2.75.

The purpose of this book is to establish as close a relationship as possible between facts and theories within the rather limited time usually allotted to Qualitative Analysis.

The book is divided into five parts: **Part 1:** Fundamental principles are discussed and illustrated with useful problems. **Part 2:** Reactions of cations are considered with fundamental principles. **Part 3:** Preliminary experiments are given which are designed to cause the student to apply the facts and theories learned in **Parts 1** and **2. Part 4:** A clear concise outline supplemented with notes is given for the preparation of the solution. The scheme of analysis consists of six groups. These groups are separated as follows: I. *Hydrochloric acid. . .*Pb, Hg, Ag; II. *Hydrogen sulfide. . .*Pb, Bi, Cu, Cd, Hg, As, Sb, Sn, subsequently divided into a basic and acid division with sodium sulfide; III. *Ammonium hydroxide in presence of ammonium chloride. . .*Al, Cr, Fe; IV. *Ammonium hydroxide and hydrogen sulfide. . .*Mn, Zn, Co, Ni; V. *Ammonium carbonate and alcohol. . .*Ba, Ca, Sr, Mg; VI. NH_4, K, Na *remain in final filtrate.* Provision is made for optional methods of analysis in special cases and for treatment when phosphates are present. **Part 5:** A *scheme of anion analysis* is developed in considerably more detail than is found in elementary texts.

The book has accomplished its aim in correlation of principles and facts as well as could be expected in a text designed to be covered in the somewhat limited time now allowed for qualitative analysis courses. The print is pleasing and the material logically arranged. If the author could have included in **Part 4** a place for the separation and detection of some of the more common "rare elements," it would have added to the value of the book, since the commercial analyst of today is frequently called upon to detect the presence of such elements.

K. KERSHNER

MISSOURI SCHOOL OF MINES
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Work Book in General Science. ELLIS C. PERSING, M.S., and KIMBER M. PERSING, M.S. Harter Publishing Company, Cleveland, Ohio, 1927. 127 pages. 21 × 27 cm. $0.60.

A "work book" is a teaching aid that keeps the individual student busy for a time at interesting, instructive activity with mind and pencil; in which results are recorded in blanks on the pages of the book itself rather than in a separate notebook; in which the directions are so given that each pupil may go at his own pace.

Work books in science have the general appearance of laboratory manuals, but, unlike most of them, go farther in presenting references, thought questions, and problems to be worked out.

Work books in general science, such as this by the Persing brother-teachers, present a great variety of content material experimentally, invite the student to help himself rather than pass his plate to the teacher for each measured slice. The "project method," the "contract plan," and similar schemes of making assignments and checking performances, will find work books of particular assistance. It is conceivable that the work book could be used unaccompanied by any text, but this is not recommended by the authors.

This Work Book in General Science possesses interest, practicability, variety, and a good arrangement according to seasons—*e. g.*, the study of plants and animals comes near the end, which would ordinarily be reached in the spring. Teachers of general science, particularly those harassed by large classes, should investigate the service that such a work book might render.

H. A. WEBB
GEORGE PEABODY COLLEGE FOR TEACHERS
NASHVILLE, TENNESSEE

College Organic Chemistry. E. EMMET REID, Professor of Chemistry, The Johns Hopkins University. D. Van Nostrand Company, Inc., 250 Fourth Ave., New York City, 1929. v + 649 pp. 14 × 21.5 cm. $3.75.

The volume is the fruit of the author's valuable experience in teaching organic chemistry and is intended for a year course. That it differs somewhat in order from the older texts is not an adverse criticism since there is more than one successful way of presenting in an orderly manner this difficult subject.

One especially valuable characteristic of the book, a resultant of the research interests of the author, is shown in the space devoted to helpful and comprehensive tabulations of the physical properties of analogous series.

In the 78 tables in the book, an immense amount of information is collated and arranged to show the relationship between members of the same series. For example, Tables XI and XII give the structure of 7 heptanes, together with data concerning the boiling point, melting point, density, critical temperature, pressure in atmospheres, surface tension, refractive index, and dielectric constants of each isomer. In addition some 27 figures in the aliphatic series illustrate, for instance, vapor pressure curves, boiling points of *n*-primary alcohols, ethers, esters, amines, the density of hydrocarbons, and some of their substitution products, etc.

After an introduction which stresses the theory of steam-distillation and the distillation of organic mixtures the author discusses methane and methanol as type compounds, continued by chapters on building molecules, the methane series, isomerism, halogen derivatives, and then ethanol which is taken up in detail. Then follow the customary topics which are taken up with clarity of style and full presentation of typical reactions, together with unusual care in pointing out relationships between compounds, all of which should be helpful to the student. Many references are given to technical applications, both industrial and medical. At the end of each chapter are a number of illustrative problems.

One question might be raised about the volume, and that is the relative amount of space devoted to the cyclic compounds (26%). In view of their importance in so many industries and as medicinal agents this part could be well expanded but not at the expense of the aliphatic compounds.

The book can be recommended as a well-presented and excellent volume containing a wealth of tabular material not usually found in an elementary organic chemistry text.

F. B. DAINS
UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

Some Applications of Organic Chemistry to Biology and Medicine. GEORGE BARGER, Edinburgh University. McGraw-Hill Book Company, Inc., New York, 370 Seventh Avenue, 1930. 186 pp., 5 figs. 15 × 23 cm. $2.50.

This book consists of an introductory lecture on international relations in science and five lectures dealing with the chemistry of the hormones, the vitamins, chemical constitution and physiological action, chemotherapy, and the blue adsorption compounds of iodine. With the possible exception of the last lecture, all these subjects are of great general interest. The skill with which the author

has presented a not inconsiderable amount of organic chemistry in a very readable form will awaken the envy of all those who have struggled with similar problems in their own teaching. Of course, it is always a relatively easy matter to handle a complicated technical matter if one is content to give merely the bare outlines and then entertain the audience by anecdotes and startling statements, but to present both a popular and adequate account of a subject as the author has done is extraordinarily difficult. Not only are the more striking aspects of each subject considered, but the whole chemical and physiological background is carefully explored; for instance, in the case of thyroxin the synthesis of this compound and the experiments leading to the establishment of the constitutional formula are discussed in great detail. This part of the book will be of particular interest to the specialist in this field since it is well known that Professor Barger is in a unique position to speak with authority on this subject. He allows us here a glimpse of the actual steps by which an important investigation was brought to a successful conclusion. This portion of the book would make an excellent text to illustrate the methods of organic chemistry. The same emphasis on the historical development of a subject is evident in all the lectures.

In the preface the author says "The composite nature of my audience, consisting of biologists and of chemists, induced me when lecturing to aim at a general survey and the exposition of first principles." The author has succeeded in this aim and has produced a book of great interest to biologists and chemists and of particular value for younger students who are first making their acquaintance with organic chemistry and its applications to biology. Portions, if not all of the book, might very well be assigned as reading in a first course in organic chemistry.

J. B. CONANT

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The Normal Diet. W. D. SANSUM, M.S., M.D. Third revised edition, The C. V. Mosby Co., St. Louis, Mo., 1930. 134 pp. 13 × 19.5 cm. $1.50.

The material of this book is taken from a course of lectures given by the author to patients suffering from nutritional diseases. The food requirements of the body are fully explained. A chapter is devoted to each of the following topics: calorie, bulky food, protein, mineral, vitamin, and water requirement for the body. The author points out the relation of diet to some of the nutritional disorders, for example, and acid-ash and the acetone types of acidosis, diabetes, and the typical diseases due to the lack of vitamins. The diet menus are completely revised, and many special menus are added. Sample menus for alkaline diet containing different calorie content, also those pertaining to the proper carbohydrate and fat ratio, are of special interest and importance. Menus for reducing diets are included. The height and weight tables with explanations are a helpful part of the book.

References are given at the end of each chapter but the author has included only the ones mentioned in the text. It would seem that this list of references should have been revised and made more complete for this later edition.

The book is written to interest the medical man and to help the layman to a better understanding of the nutritional requirement of the body. It has more value in this place than as a scientific contribution.

N. M. NAYLOR

IOWA STATE COLLEGE
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The Use of the Microscope. JOHN BELLING, Cytologist, Carnegie Institution of Washington. First edition, McGraw-Hill Book Co., Inc., 370 Seventh Avenue, New York City, 1930. xi + 315 pp. 28 figs. 15 × 23 cm. $4.00.

"For scientific work it is desirable to get in the microscope the sharpest and most contrasty images possible with the

apparatus at hand. There are several dozen adjustments, or variations of methods, each of which will add slightly to the perfection of the image in the microscope. Alone, each of these slight improvements may not seem worth making; but combined they may cause a decided difference in the brilliancy and crispness of the microscopical image. In this book, the most important of these methods have been brought together from the original papers, and to them have been added the results of the writer's experience gained in years of continuous work with the microscope." The author thus presents his book as a work on critical microscopy rather than an elementary or general treatise. He discusses various important phases of microscopy, notably simple magnifiers, binocular microscopes, the water immersion objective, corrections of condensers, cover-glass thickness, and the limitation of illumination to the area of the field of view, as well as most of the topics commonly included in elementary works. Each chapter closes with a list of "practical points." A glossary of terms and a chapter on the literature of [critical] microscopy with a bibliography are included. There is also a set of study questions, of the "memory" type. Polarized light and ultramicroscopy are not discussed, and photomicrography is dismissed very sketchily.

The work is more of a commentary or *vade mecum* than an exposition of principles; indeed, the reader will need to seek his fundamentals and theory elsewhere. It seems unfortunate that important manipulative technic, readily adaptable to all fields of microscopy, should not be described and illustrated in such a manner as to suggest its very wide significance. The sections on "Discoveries with the Microscope" and "A Hundred Microscopical Objects of Biological Interest" serve further to place emphasis on the *class of objects* with which the author and biologist in general are most concerned, rather than upon the *microscope as an instrument* for the revelation of fine detail in any sort of material. Since there is no mention of the chemical or technical use of the microscope, and indeed little specific reference to the problems of technic encountered in general biological applications, the chief value of the book is likely to cytologists.

The chemist will profit most from the chapter on "Fifty Practical Exercises with the Microscope," in which the author has gathered together a series of experiments designed to exemplify the defects in microscopical images and the effectiveness of the different methods of correcting them. These exercises may profitably be performed by every user of the microscope, whatever his field, as an excellent training in obtaining optimum contrast and detail. Numerous items of information, and some criticisms of apparatus, will also be of particular value to microscopists who are qualified to recognize that on some there is a difference of opinion, and to evaluate them in terms of wider demands than those of cytology.

C. W. MASON

CORNELL UNIVERSITY
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The New World of Physical Discovery. FLOYD L. DARROW. The Bobbs-Merrill Company, Indianapolis, Ind., 1930. viii + 371 pages. 15.5 × 23 cm. Illustrated. $3.50.

This is a popular history of physics. Its author understands that recent developments cannot be set forth clearly except in the light of earlier history, and devotes several chapters to an account of the classical physics from earliest times to the establishment of the laws of the conservation of mass and of energy and the kinetic theory of heat. He describes the well-ordered Victorian universe, filled with ether and impenetrable atoms, where the future seemed predictable and where there seemed no more really important discoveries to be made. Against this background he delineates dramatically the disturbing discoveries of the new physics, the interconnectedness of matter and energy and the relativity of all things.

The book is very readable, but too slangy in parts and too much like a Sunday supplement for the taste of a sober student of science. But these qualities will perhaps make it more acceptable to the greater number. It is clear throughout, has no noteworthy gaps in the narrative, and in places is written in language which is eloquent. It will be intelligible and interesting to those who are not trained in science. To teachers of science it will supply much which can be used in their lectures. It is the Scientific Book Club's "selection for February"—and we applaud the choice.

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Principles of Guidance. ARTHUR J. JONES, Professor of Secondary Education, School of Education, University of Pennsylvania. First edition, McGraw-Hill Book Co., Inc., New York, 1930. xxiv + 385 pp. 27 tables, 23 figures, 5 posters. 14 × 20 cm. $3.00.

In this volume the author seeks to set forth the nature of guidance and formulate its underlying principles and methods so that teachers and administrators can "see the relations of guidance to other phases of education" and thus have the "basis for proper evaluation of procedures and practices." The scope of the volume is indicated by the four parts embraced in it—(1) the meaning, purpose, and aim of guidance, (2) methods of investigation in guidance, (3) methods of guiding students, and (4) results of guidance.

Too often the treatment of problems in the mental and social sciences is defective because basic assumptions are made unconsciously—assumptions whose validity is highly questionable. The author of the present volume, however, discusses in Chapter III seven important "Basic Assumptions of Guidance," and notes at other places in the volume important assumptions underlying aims and procedures. The most enthusiastic hereditarians doubtless will reject the second of these—*viz.*, that "native abilities are not usually specialized," yet the author from a brief summary and careful evaluation of data, observations, and opinions finds some justification for the view that "success in a certain group of related vocations or schools or studies is determined more by interests early developed, by facilities, by openings, by opportunities in the particular locality or region where the individual is located" (p. 48) than by a high degree of specialization of native abilities, although he does recognize "the possibility of specialized abilities in music and art."

Part II contains twelve significant and timely chapters on such topics as general methods of investigation, studying the individual through use of (1) school records, (2) variability and flexibility of school organization, (3) tryout and exploratory activities, (4) tests, (5) estimates of personality, traits, and self-analysis, (6) case methods and the services of psychiatrist and visiting teacher, and (7) such inaccurate or useless procedures as astrology, phrenology, graphology, etc.

Part III gives a good treatment of methods of guidance with relation to courses, schools, colleges, and occupations (instruction, try-out and exploration, counseling, choosing an occupation, placement and follow-up), as well as a brief treatment of civic and moral, leisure time, social, and leadership guidance.

The treatment of aptitude tests is inadequate, no mention being made of certain prognosis tests whose value seems to be much greater than that of the Downey Will-temperament tests which are given brief mention. Similarly, the promising work on interest tests for guidance purposes is neglected.

The book is well written, with footnote references throughout and with selected references at the end of each chapter; it is comprehensive, well proportioned, and shows mature and sound scholarship. It should be of distinct value to teachers, administrators, and others interested in

educational and vocational guidance and related phases of personnel work.

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BULLETINS

The Scientific Fundamentals of Gravity Concentration. JOSEF FINKEY, E.M., Professor of Ore Dressing of the School of Mines, Sopron, Hungary. Translated into English by C. O. ANDERSON and M. H. GRIFFITTS. *Bulletin* of the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., 1930. 295 pp. 14.5 × 22 cm. $1.00.

The following chapter headings indicate the content of this *Bulletin:* I. The Principles of Mechanics of Gravity Concentration. II. Preparation for Gravity Concentration. III. Jigging. IV. Concentration.

Statistical Summary of Education, 1927–28. FRANK M. PHILLIPS, chief, Division of Statistics, U. S. Dept. of the Interior. *Bulletin*, 1930, *No. 3*. U. S. Govt. Printing Office, Washington, 1930. 16 pages. 15 × 23 cm. $0.05.

The Province of New Brunswick, Canada. Its Natural Resources and Development. L. O. THOMAS, B.Sc. Natural Resources Intelligence Service, Department of the Interior, Ottawa, Canada. 1930. 166 pp. 33 photos, maps. 17 × 25 cm. Gratis.

"The Department of the Interior has just issued a report on New Brunswick. The potentialities of this maritime province had undoubtedly been overlooked during the period of the agricultural development of Western Canada and the industrial growth of Ontario and Quebec, for it is only recently that its water power and forest wealth have been utilized in large-scale pulp and paper enterprise. Progress in this direction has indeed been remarkable. Last year the largest power site in the Maritimes was developed at Grand Falls, with an installation of 60,000 horsepower and transmission line of 104 miles to Chaleur Bay; 5500 horsepower was added to the 9000 horsepower already developed on the Nipisiguit; the capacities of the plants at Edmundston and Bathurst were enlarged; while a newsprint mill with an initial daily capacity of 250 tons came into operation in March, 1930; and a bleached sulfite mill at Athol has lately been completed.

"A similar awakening is in evidence in regard to the fertile and cheap agricultural lands, minerals and fisheries, and the many recreational attractions of the province, all of which resources and the development opportunities they present are dealt with in this governmental publication, which can be obtained from the *Director, Natural Resources Intelligence Service, Department of the Interior, Ottawa, Canada.*"

Possible Canadian Production of Radium Ore. The occurrence of small quantities of radioactive minerals in granite pegmatite dykes in Ontario and Quebec was noted many years ago, when some of these dykes began to be worked for their mica or feldspar content. A considerable variety of rare-earth minerals, many of them radioactive, have been yielded by such dykes, but not in commercial quantities. Recently, however, prospecting in the Wilberforce districts of Central Ontario has resulted in the discovery of a deposit of uraninite that appears more likely to prove of commercial grade than any hitherto found in Canada.

Uraninite is a crystallized form of pitch-blende, the richest commercial ore of radium, and is the mineral now mined at Jachymov, in Czechoslovakia, and in the Belgian Congo. From these deposits the greater part of the world's supply of radium has been obtained.—*Chem. News*